Final report

Ontario
Waste Management
Corporation

A provincial crown corporation

Gartner
Lee
Associates
Limited

SITE ASSESSMENT
PHASE 4B:
BIOLOGY

Prepared for
The Ontario Waste Management Corporation

Submitted By

Gartner Lee Limited

October, 1987

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October 16, 1987 GLL87BS1.1

Mr. J.G. Micak,
Ontario Waste Management Corporation,
2 Bloor Street West,
11th Floor,
Toronto, Ontario,
M4W 3E2

Attention: Mr. P.D. Hunt

Dear Mr. Micak:

Re: Site Assessment, Phase 4B: Biology

We are pleased to provide you with the above-noted report, which describes existing biological conditions on and in the vicinity of the preferred site and assesses impacts on the natural environment associated with the construction, operations, and post-operations stages of the proposed OWMC waste treatment and disposal facilities.

This report represents a consolidation into a single volume of material contained in two previous draft reports submitted to OWMC. Review comments on these earlier draft reports provided by OWMC staff, and the Ontario Ministry of National Resources have been incorporated into the present report.

We thank you for this opportunity to be of service and trust that this report meets with your requirements.

Yours very truly,

GARTNER LEE LIMITED

Grant Anderson

E. Grant Anderson, P.Eng.,
Project Director.

DMF:jcm

SITE ASSESSMENT, PHASE 4B: BIOLOGY

TABLE OF CONTENTS

PAGE

LETTER OF TRANSMITTAL
TABLE OF CONTENTS
STUDY TEAM
EXECUTIVE SUMMARY (i)

1.0 INTRODUCTION 1
- 1.1 PURPOSE OF THIS REPORT 1
- 1.2 BACKGROUND 3
- 1.3 SCOPE 4
- 1.4 STUDY AREAS 7
- 1.5 TIME HORIZONS 10
- 1.6 FACTORS AND INDICATORS 10
- 1.7 LIMITATIONS 12
- 1.8 ROLE OF THE PUBLIC AND AGENCIES 13

2.0 DATA COLLECTION METHODS 15
- 2.1 EXISTING DATA 15
- 2.2 MINISTRIES AND AGENCIES 16
- 2.3 PUBLIC AND SPECIAL INTEREST GROUPS 16
- 2.4 FIELD DATA COLLECTION METHODS 17
- 2.4.1 VEGETATION - SITE AND VICINITY 17
- 2.4.2 WILDLIFE - SITE AND VICINITY 19
- 2.4.3 FISHERIES - SITE AND VICINITY 23
- 2.5 DATA INPUTS/OUTPUTS 25

3.0 EXISTING CONDITIONS 27
- 3.1 INTRODUCTION 27
- 3.2 VEGETATION 27
- 3.2.1 REGIONAL VEGETATION 28
- 3.2.2 SITE VEGETATION 28
- 3.2.2.1 Forest 29
- 3.2.2.2 Thicket 36
- 3.2.2.3 Marsh 36
- 3.2.2.4 Field 37
- 3.2.3 SITE VICINITY VEGETATION 37
- 3.2.3.1 Forest 37
- 3.2.3.2 Thicket 42
- 3.2.3.3 Marsh 42
- 3.2.3.4 Field 43
- 3.2.4 FACILITY SERVICING CORRIDORS 43
- 3.2.5 REPRESENTATIVENESS OF VEGETATION 45
- 3.2.6 RARE PLANT SPECIES 49
- 3.2.6.1 Site 50
- 3.2.6.2 Site Vicinity 53

PAGE

3.3 WILDLIFE 55
3.3.1 SITE 55
3.3.1.1 Birds 55
3.3.1.2 Mammals 59
3.3.1.3 Reptiles and amphibians 64
3.3.1.4 Butterflies 65
3.3.2 SITE VICINITY 65
3.3.2.1 Birds 65
3.3.2.2 Mammals 68
3.3.2.3 Reptiles and amphibians 71
3.3.2.4 Butterflies 72
3.3.3 RARE WILDLIFE SPECIES 72

3.4 FISHERIES 74
3.4.1 9C CREEK 74
3.4.1.1 Aquatic habitat 74
3.4.1.2 Fish community composition 76
3.4.2 BEAVER CREEK 77
3.4.2.1 Aquatic habitat 77
3.4.2.2 Fish community composition 79
3.4.3 WELLAND RIVER 82
3.4.3.1 Aquatic habitat 82
3.4.3.2 Fish community composition 84
3.4.4 RARE FISH SPECIES 86

3.5 OTHER BIOLOGICAL CONSIDERATIONS 87
3.5.1 SIGNIFICANT ENVIRONMENTAL UNITS (SEUs) 87
3.5.2 SILVERDALE WOODS HERONRY 89
3.5.3 FISH SPAWNING AREAS 90
3.5.4 COMPARISON OF PHASE 4A AND PHASE 4B DATA 91
3.5.5 RESOURCE USE 93
3.5.5.1 Forestry 93
3.5.5.2 Trapping 94
3.5.5.3 Hunting 94

3.6 FUTURE SCENARIOS 95

4.0 FACILITY CHARACTERISTICS 103

4.1 PHYSICAL-CHEMICAL TREATMENT PLANT 105
4.2 INCINERATOR 105
4.3 LANDFILL 106
4.4 FACILITY SERVICING OPTIONS 106
4.5 SURFACE WATER DRAINAGE 107
4.6 FENCING AND BERMING 107
4.7 CONSTRUCTION ACTIVITIES 108
4.8 OPERATIONAL AND MAINTENANCE ACTIVITIES 108
4.9 POST-OPERATIONAL ACTIVITIES 109

PAGE

5.0 **IMPACT PREDICTION** 110

- 5.1 INTRODUCTION 110
- 5.2 SCOPE AND OBJECTIVES 110
- 5.3 STUDY AREAS 111
- 5.4 TIME HORIZONS 111
- 5.5 FACTORS AND INDICATORS 112
- 5.6 IMPACT PREDICTION PROCESS 116
- 5.7 ASSUMPTIONS AND LIMITATIONS 123
- 5.8 RESULTS OF IMPACT PREDICTION ANALYSIS 125
- 5.8.1 PREDICTED IMPACT OF MODERATE SIGNIFICANCE 133
- 5.8.2 RELATION OF IMPACTS TO FEDERAL, PROVINCIAL AND MUNICIPAL STANDARDS AND GUIDELINES 134
- 5.8.2.1 Federal 134
- 5.8.2.2 Provincial 135
- 5.8.2.3 Municipal 138
- 5.8.3 IMPACTS WITHIN A REGIONAL AND PROVINCIAL CONTEXT 140
- 5.9 SUMMARY 141
- 5.10 PREDICTED IMPACTS AND FUTURE SCENARIOS 142

6.0 **MITIGATION** 145

- 6.1 INTRODUCTION 145
- 6.2 MITIGATION METHODS 146
- 6.3 MITIGATION OPTIONS 148

7.0 **RESIDUAL IMPACTS AND CONTINGENCY** 157

- 7.1 RESIDUAL IMPACTS 157
- 7.2 CONTINGENCY 159

8.0 **MONITORING** 161

- 8.1 INTRODUCTION 161
- 8.2 MONITORING APPROACH 161
- 8.3 MONITORING OPTIONS 165
- 8.4 SITE DECOMMISSIONING 166

9.0 **SUPPLEMENTARY INVESTIGATIONS** 169

10.0 **CONCLUSIONS AND RECOMMENDATIONS** 170

- 10.1 CONCLUSIONS 170
- 10.2 RECOMMENDATIONS 172

11.0 **ACKNOWLEDGEMENTS** 179

12.0 **REFERENCES** 180

13.0 **APPENDICES** 200

LIST OF FIGURES

		PAGE
FIGURE 1:	FACILITIES DEVELOPMENT PROCESS	2
FIGURE 2:	PREFERRED SITE	5
FIGURE 3:	PHASE 4B BIOLOGY STUDY PROCESS	6
FIGURE 4:	PHASE 4B BIOLOGY STUDY AREAS	8
FIGURE 5:	VEGETATION AND WILDLIFE SAMPLING STATIONS ON PREFERRED SITE	Back pocket
FIGURE 6:	VEGETATION AND FISH AND WILDLIFE SAMPLING STATIONS IN SITE VICINITY, BEAVER CREEK, AND WELLAND RIVER	Back pocket
FIGURE 7:	VEGETATION COVER TYPES ON PREFERRED SITE	Back pocket
FIGURE 8:	RARE PLANT AND ANIMAL SPECIES ON PREFERRED SITE	Back pocket
FIGURE 9:	RARE PLANT AND ANIMAL SPECIES IN SITE VICINITY	Back pocket
FIGURE 10:	RELATIVE ABUNDANCE OF FOUR SPECIES OF SMALL MAMMALS, SITE AND SITE VICINITY (AUGUST-SEPTEMBER, 1986)	62
FIGURE 11:	SIGNIFICANT BIOLOGICAL FEATURES AND RESOURCE USE, SITE AND SITE VICINITY	Back pocket
FIGURE 12:	PERSPECTIVE OF CENTRAL OPERATING AREA	104
FIGURE 13:	ECOSYSTEM COMPONENTS, SITE AND SITE VICINITY STUDY AREAS	117
FIGURE 14:	PHASE 4B BIOLOGICAL IMPACT PREDICTION PROCESS	118
FIGURE 15:	SPATIAL DISTRIBUTION OF BIOLOGICAL IMPACT AGENTS/RECEPTORS ON AND ADJACENT TO PREFERRED SITE	Back pocket
FIGURE 16:	SPATIAL DISTRIBUTION OF BIOLOGICAL IMPACTS SOUTH OF PREFERRED SITE	131
FIGURE 17:	SPATIAL DISTRIBUTION OF ALTERNATIVE MITIGATIVE MEASURES, SITE AND SITE VICINITY	Back pocket

LIST OF TABLES

PAGE

TABLE 1: AREAL EXTENT OF VEGETATION COVER TYPES ON THE PREFERRED SITE 30

TABLE 2: SUMMARY OF PREFERRED SITE STAND CHARACTERISTICS 31

TABLE 3: SUMMARY OF SITE VICINITY STAND CHARACTERISTICS 39

TABLE 4: BREEDING BIRDS RECORDED ON THREE DECIDUOUS WOODLAND PLOTS, SITE AND SITE VICINITY 57

TABLE 5: BREEDING BIRDS RECORDED ON TWO WEEDY FIELD PLOTS, SITE AND SITE VICINTIY 58

TABLE 6: NUMBER OF TRAPS, TRAP NIGHTS, AND CATCH PER 100 TRAP NIGHTS (TN) FOR FIVE MAMMAL TRAPPING TRANSECTS, SITE AND SITE VICINITY (AUGUST-SEPTEMBER, 1986) 60

TABLE 7: NUMBER OF CAPTURES, CATCH PER 100 TRAP NIGHTS (TN) AND PERCENT OF TOTAL CATCH REPRESENTED BY EACH SMALL MAMMAL SPECIES, SITE AND SITE VICINITY (AUGUST-SEPTEMBER, 1986) 61

TABLE 8: NUMBER OF FISH CAUGHT IN MINNOW TRAPS IN 9C CREEK AND BEAVER CREEK ON AUGUST 11, 1986 78

TABLE 9: NUMBERS OF FISH CAUGHT IN WELLAND RIVER AT MOUTH OF BEAVER CREEK (STATION #2) (APRIL-SEPTEMBER, 1986) 80

TABLE 10: NUMBERS OF FISH CAUGHT IN WELLAND RIVER AT MOUTH OF 9C CREEK (STATION #1) (APRIL-SEPTEMBER, 1986) 81

TABLE 11: SCENARIO 1 - DEGRADED ENVIRONMENT 98

TABLE 12: SCENARIO 2 - IMPROVED ENVIRONMENT 99

TABLE 13: SCENARIO 3 - PROBABLE FUTURE ENVIRONMENT 100

TABLE 14: PHASE 4B BIOLOGICAL IMPACT FACTORS 113

LIST OF TABLES (CONT'D) PAGE

TABLE 15: SUMMARY OF POTENTIAL BIOLOGICAL IMPACTS ASSOCIATED WITH FACILITY CONSTRUCTION STAGE 126

TABLE 16: SUMMARY OF POTENTIAL BIOLOGICAL IMPACTS ASSOCIATED WITH FACILITY OPERATIONS AND AND POST-OPERATIONS STAGES 127

TABLE 17: SUMMARY OF SPECIFIC BIOLOGICAL IMPACTS IDENTIFIED IN TABLES 15 AND 16 128

TABLE 18: MITIGATIVE OPTIONS AND THE NET EFFECT OF EACH 149

TABLE 19: BIOMONITORING OPTIONS 167

TABLE 20: SUMMARY OF BIOLOGICAL IMPACTS, SIGNIFICANCE OF IMPACTS, AND IMPACT MITIGATION OPTIONS 174

LIST OF APPENDICES

PAGE

APPENDIX A: PUBLIC AND AGENCY CONTACTS - PHASE 4B BIOLOGY A-1

APPENDIX B: OWMC PHASE 4B BIOLOGY FIELD PROTOCOL B-1

APPENDIX C: CHECKLIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY C-1

APPENDIX D: COMPARISON OF TREE IMPORTANCE VALUES IN THE SITE AND SITE VICINITY STUDY AREAS AND IN THE DECIDUOUS FOREST REGION OF ONTARIO D-1

APPENDIX E: SUMMARY OF QUANTITATIVE STAND DATA E-1

APPENDIX F: RARITY AND SIGNIFICANCE OF PLANT SPECIES F-1

APPENDIX G: LIST OF BIRD SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY G-1

APPENDIX H: LIST OF MAMMAL SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY H-1

APPENDIX I: LIST OF AMPHIBIANS AND REPTILES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY I-1

APPENDIX J: LIST OF BUTTERFLY SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY J-1

APPENDIX K: LIST OF FISH SPECIES RECORDED IN 9C CREEK, BEAVER CREEK AND THE WELLAND RIVER K-1

APPENDIX L: RARITY AND SIGNIFICANCE OF FISH AND WILDLIFE SPECIES L-1

APPENDIX M: GLOSSARY M-1

APPENDIX N: DEFINITIONS OF VEGETATION COVER TYPES N-1

OWMC PHASE 4B BIOLOGY STUDY TEAM

The study was carried out under the direction of Grant Anderson, Project Director, Gartner Lee Limited (GLL). The study team consisted of:

Dave Osmond, B.Sc.Agr.	Associate and Senior Biologist of GLL - Report Review
Kenneth Dance, M.Sc.	Associate and Senior Biologist of GLL - Report Writing and Project Management
Thomas Hilditch, B.Sc.Agr.	Biologist of GLL - Report Writing and Data Collection - Botany
Donald Fraser, M.Sc.	Biologist of GLL - Report Writing and Data Collection - Fisheries and Wildlife
Bradley Parker, B.Sc.	Former Biologist of GLL - Data Collection - Fisheries

The Gartner Lee team was assisted by four Technical Advisors:

Dr. Henry Regier	University of Toronto Technical Advisor - Fisheries
Dr. Paul Maycock	University of Toronto Technical Advisor - Botany
Dr. John Theberge	University of Waterloo Technical Advisor - Birds and Mammals
Mr. Ross MacCulloch, M.Sc.	Royal Ontario Museum Technical Advisor - Herpetology

EXECUTIVE SUMMARY

PURPOSE OF THE REPORT

- To define the existing biological conditions (baseline) of the preferred siting option.
- To predict and assess potential impacts on the biological resources associated with the proposed facility.
- To identify and develop appropriate mitigative measures to minimize these potential impacts.
- To identify residual impacts which remain following the application of mitigation.
- To identify and develop a biomonitoring program that will be implemented to assess the effectiveness of the facility design and operations in minimizing impacts in the biological resources.
- To prepare documentation to meet the requirements of Ontario's Environmental Assessment Act.

SCOPE AND METHODS

The following study areas were examined:

- the preferred site
- the site vicinity (approximately 2 km radius surrounding the site)
- a portion of the Welland River (downstream of the site)
- facility servicing corridors (e.g., electricity, potable water, natural gas, etc.)

Field data collection was carried out over a 12-month period to allow a characterization of existing biological conditions during all four seasons. Field work was concentrated in the spring and summer months (April to September).

The Phase 4B Biology study involved the following tasks:

- preparation of a detailed field protocol document;
- field studies, which involved quantitative vegetation analyses; vegetation cover type mapping, winter and breeding bird censuses; small mammal trapping; reptile, amphibian and butterfly observations; fish sampling; aquatic habitat assessment;

- review of the scientific literature; discussions with ministry and agency personnel, special interest groups, and the public

- data compilation, analysis, interpretation and reporting.

The protocol consists of procedural directives to guide field staff (GLAL 1986). The biology and methodological protocol is included as Appendix B of this report.

Details of data collection methods are contained in Section 2.0 of this report.

PREMISES AND POSTULATES

The identificiation of the appropriate scope of the study and the approach to data collection and interpretation was established by the GLL Study Team in consultation with OWMC personnel. Assumptions regarding facility characteristics and outputs were obtained from other OWMC consultant's reports and are described in Section 4.0. Data collection and analysis procedures employed during Phase 4B were consistent with those in general practice for the various biology sub-disciplines (vegetation, wildlife, fisheries). Accepted, published data collection and analysis methods were followed.

STATUS OF DATA

The information base collected during the Phase 4B biology program is considered to be acceptable for its intended purpose, namely the definition of pre-facility (baseline) biological conditions on and in the vicinity of the preferred site. Some of this information has been used by other OWMC engineering consultants in the conceptual design of the proposed OWMC facility and provides the basis for GLL's assessment of potential impacts on biological resources. The baseline information can also be used as the basis for comparison with the results of future monitoring of impacts.

Data were also obtained from published literature, discussions with government agencies, academic institutions, special interest groups and experts knowledgeable in various fields of biological science.

MAIN FINDINGS

VEGETATION

The existing vegetation of the site and site vicinity study areas is described in Section 3.2 of this report.

No species listed in the Ontario Endangered Species Act occur on the site.

Vegetation patterns are strongly influenced by the geographic setting and physical conditions of the area. The preferred site is situated within the Deciduous Forest Region, the most southerly forest region in Canada. The distribution of upland and lowland vegetation communities is influenced by the ridge-swale topography of this area. The poorly drained surface soils create wet sloughs throughout the area.

Over half of the 124 ha site has been cleared of forest and is presently used for agricultural crop production. The remaining natural vegetation is represented by a mosaic of the following cover types: forest, thicket, recently disturbed field, old field and marsh.

Forested stands on-site are dominated by tree species and associations which are characteristic of the Deciduous Forest Region. These include Red, Sugar and Silver Maples, White Ash and White and Swamp White Oak.

The vegetation in the site vicinity study area is also characterized by a mosaic of forest, thicket, marsh and field. Several large forested tracts occur to the north of the site and are dominated in various places by associations of White and Red Oak, Sugar Maple and American Beech, and White Ash and Red Maple.

The results of the detailed Phase 4B vegetation analysis were compared with similar data obtained from other forest stands throughout the Deciduous Forest Region of Ontario. These comparisons indicate that the vegetation growing on the site and in the site vicinity are comprised of typical tree associations and representative of conditions which prevail throughout the Niagara Peninsula and elsewhere in southwestern Ontario.

Of the 441 plant species encountered in the site and vicinity study areas, eight are considered rare based on accepted literature sources. Three are provincially and nationally rare and the remainder are regionally rare. Rarity infers a lack of abundance or a scattered, restricted occurrence of a species within a given geographic area. In order to evaluate the rarity of the eight plant species relative to each other, a level of significance (high, medium, or low) was assigned to each. One rare species is considered to be of high significance, six of medium significance and one of low significance: The status and significance of each of these rare species are discussed in detail in Appendix F of this report.

WILDLIFE

The results of the wildlife component of the Phase 4B biology study are contained in Section 3.3. The birds, mammals, reptiles, amphibians and butterflies which inhabit the preferred site and site vicinity are generally comprised of common species which are typically found in the various habitats present.

One provinically rare breeding bird species, Cerulean Warbler, was recorded on the site but did not exhibit any evidence of nesting. An inactive Great Blue Heron colony was found just outside the site vicinity. An active heronry, one of only three in the Niagara District, was found several kilometres due west of the site vicinity.

Small mammal populations are also comprised of common species. White-tailed Deer use the site as part of an east-west movement corridor linking small, isolated woodlots. However, the majority of deer in the area reside in the larger wooded tracts to the north of the site.

One provincially rare mammal species, the Virginia Opossum, was recorded during the study. However, this species is common and of widespread distribution throughout the Niagara Peninsula and its occurrence is not considered significant.

None of the reptile, amphibian and butterfly species recorded in the site and vicinity study areas during Phase 4B is considered rare of otherwise significant.

The presence of several other rare animal species reported to GLL during Phase 4A was not confirmed by Phase 4B investigations.

FISHERIES

Fish sampling and aquatic habitat assessment was conducted in the Welland River, Beaver Creek and 9C Creek (an unnamed creek which drains the site and discharges into the Welland River). The results of these analyses are documented in Section 3.4.

Locally significant spring spawning runs of Northern Pike occur in the Welland River and Beaver Creek. Several other sport fish species inhabit these watercourses. Few fish species were found in 9C Creek, where pike spawning habitat is limited in both extent and quality.

Fish community composition in the Welland River and Beaver Creek is largely composed of common warm water species, typically found in rivers entering the lower Great Lakes. No rare fish species were recorded during the Phase 4B study. An earlier report of the occurrence of one provincially rare fish species from the Welland River is believed to be erroneous.

The Welland River acts as a migration route for fish entering local tributaries to spawn. It is also considered a Class 1 wetland and thus is "provincially significant".

OTHER BIOLOGICAL CONSIDERATIONS

Portions of three Significant Environmental Units (SEUs) occur in the site vicinity (Section 3.5). None occur on the site. All three are considered Environmentally Sensitive Areas (ESAs) within the Regional Municipality of Niagara and two are identified as areas of Natural and Scientific Interest (ANSIs) by the Ontario Ministry of Natural Resources. One of the ANSIs is also recognized as a Class 2 wetland and therefore of "provincial significance"

RESOURCE USE

Evidence of recent and past forestry activity (fuelwood and sawlog production) was observed in several woodlots throughout the site and vicinity (Section 3.5). Two forested areas are subject to Woodlot Improvement Agreements.

Muskrats and Raccoons are trapped in roadside ditches and wet sloughs throughout the area by one licensed trapper. Some deer, waterfowl and upland game hunting apparently occurs in the site vicinity, but to a very limited extent.

FUTURE SCENARIOS

Three different scenarios of future biological conditions which might arise in the absence of the OWMC facility were developed (Section 3.6). These scenarios include a "degraded" environment at one extreme, an "improved" environment at the other extreme, and an "expected" environment, which involves a combination of the other two. Changes which might occur were predicted from the present to the year 2000 and were influenced by factors such as agricultural practices, other land use activities, and governmental and non-governmental programs regarding environmental and land use planning issues.

IMPACT PREDICTION

Potential impacts on the biological resources of the preferred site and site vicinity associated with the proposed construction and operation of the OWMC facility were assessed (Section 5.0). This involved a determination of all potential impacts and the spatial distribution, frequency, duration, magnitude, reversibility, potential for occurrence and significance of each.

Two biological impact factors and six impact indicators were developed to provide an organizational framework within which data regarding impacts were identified and assessed. Tables, maps, and matrices were used extensively to summarize these data (Section 5.8).

Forty-six potential biological impacts associated with facility construction and operations were identified. These were aggregated in to 18 specific biological impacts, in order to avoid duplication and focus the discussion. None of these impacts was considered to be of "major" significance. One of the 18, loss of rare plant species on-site, was considered of "moderate" significance and the remainder of "minor" significance.

Impacts of moderate significance are defined as those which affect a portion of a population or community with a small regional population and distribution but a large provincial and/or national population and distribution. Impacts of minor significance are defined as those which affect a portion of a population or community with a large regional and provincial population and distribution.

The majority of impacts are expected to occur on the preferred site, including the one impact of moderate significance (loss of rare plant species on-site). With the possible exception of minor, indirect effects on three rare plant species growing adjacent to the site, none of the significant biological resources of the site vicinity or Welland River are expected to receive impacts.

Examples of "minor" impacts which might occur include:

- removal of on-site vegetation and loss of associated wildlife habitat;

- vegetation removal and loss of wildlife habitat along Heaslip Road right-of-way;

- site perimeter fencing preventing deer from using site as part of east-west movement corridor;

- incinerator and evaporator stacks as obstacles to migratory birds;

- potential damage to adjacent vegetation, including three rare species, due to on-site construction activity;

- change in soil moisture due to construction of perimeter ditching; and
- reduced flow in 9C Creek affecting downstream aquatic life.

Within a regional and provincial context, the biological impacts are likely to be comparable to those associated with a development of a similar scale. The results of the biological impact prediction analysis confirm the basic acceptability of the preferred site and fulfill the OWMC objective of minimizing environmental impacts.

MITIGATION

Once impacts had been identified and assessed, appropriate alternative mitigative measures were formulated (Section 6.0). Among these a preferred mitigative option was chosen for each of the 18 specific impacts.

The effectiveness of each mitigative option in terms of preventing, minimizing, rectifying, compensating or enhancing each impact was also assessed and permitted the identification of residual impacts. Residual impacts are those impacts which remain following the implementation of mitigation.

Examples of preferred mitigative options include:

- removing perimeter fencing following decommissioning;
- clearing vegetation on-site on an as-needed basis and progressively revegetating landfilled areas with appropriate plant cover;

- transplanting to suitable off-site habitat and collecting propagules of rare species on-site to perpetuate the gene pool;
- employing careful felling techniques to protect adjacent vegetation from construction activity;
- designing drainage systems to minimize changes in soil moisture regime; and
- replanting vegetation along Heaslip Road to replace wildlife habitat.

MONITORING

Monitoring of biological conditions will test impact predictions, evaluate the effectiveness of mitigative efforts and identify trends or changes either due to natural processes or generated by the OWMC facility (Section 8.0).

Bioassay monitoring studies of indicator organisms are designed to identify contaminant sources, trace pathways and assess toxicological effects. Ecological monitoring studies are intended to monitor changes in population levels, species diversity and distribution, and community structure.

Various life forms are proposed as possible indicator organisms, including fish, insect and fish-eating birds, mosses and lichens and vegetation communities.

CONCLUSIONS

Based on the results of the Phase 4B biology study, the following conclusions have been reached:

- The natural vegetation of the preferred site and site vicinity study areas is characterized by a mosaic of woodland, thicket, marsh, old field and recently disturbed fields;
- The vegetation is representative of the Deciduous Forest Region of Ontario and is typical of that which is found elsewhere on the Haldimand Clay Plain;
- Six rare plant species occur on the preferred site and four rare plant species (including two not found on the site) occur in the site vicinity;
- The wildlife communities inhabiting the study areas are representative of typical southern Ontario situations;
- One rare bird species was recorded on the preferred site and one rare mammal species was recorded on both the site and in the site vicinity;
- The fish community inhabiting the Welland River is comprised primarily of coarse fish species typically found in slow moving turbid rivers in the Lake Erie drainage basin;
- The Welland River and Beaver Creek support spawning runs of Northern Pike;

- Three Significant Environmental Units (SEUs) occur in the site vicinity;

- Some tree cutting, hunting and trapping occur on the site and in the site vicinity;

- The majority of impacts associated with construction of the OWMC facility are of minor significance and are expected to be confined to the site and areas immediately adjacent to the site margins;

- Loss of natural vegetation wildlife habitat, removal of a deer corridor, displacement of wildlife, and loss of rare plant species are the primary on-site impacts;

- Off-site impacts are expected to be localized and will affect small areas of vegetation, fish and wildlife habitat adjacent to the site and along facility corridors;

- Few impacts (all of minor significance) are expected to occur during the operations and post-operations stages;

- The application of proposed mitigative measures is expected to reduce the impact of certain construction and operations activities so that residual impacts are of minor significance;

- Facility decommissioning provides the opportunity to remove obstacles and to rehabilitate the site to allow replacement of lost habitat;

- Monitoring will allow testing of impact predictions and identify changes or trends in the natural environment (either attributable to natural processes or project-induced pertubations);

- The results of the Phase 4B biology study confirm the basic acceptability of the site for development of the OWMC facility; and

- The results of the impact prediction analysis and recommended mitigation measures, contingency planning, and monitoring programmes fulfill the OWMC objective of minimizing environmental impacts.

RECOMMENDATIONS

We suggest that OWMC implement the following recommendations:

- design and initiate a monitoring program which makes several years of preconstruction baseline data available, assesses the nature of impacts during facility construction and operation and evaluates the effectiveness of mitigation;

- ensure that stream crossings along access roads are considered in spill contingency planning;

- in selecting plant species and designing vegetation treatments on berms and elsewhere on the site, consideration should be given to re-establishing tree species which have commercial and social values for the local community and vegetation which has value for wildlife in terms of providing food and shelter;

- obtain biological input in the detailed design of the pumping station and water intake storm water outfall;

- at the outset of construction, review the feasibility of clearing on an as needed basis, along with progressive rehabilitation; and

- implement the preferred mitigation options outlined in Section 6.0 of this report.

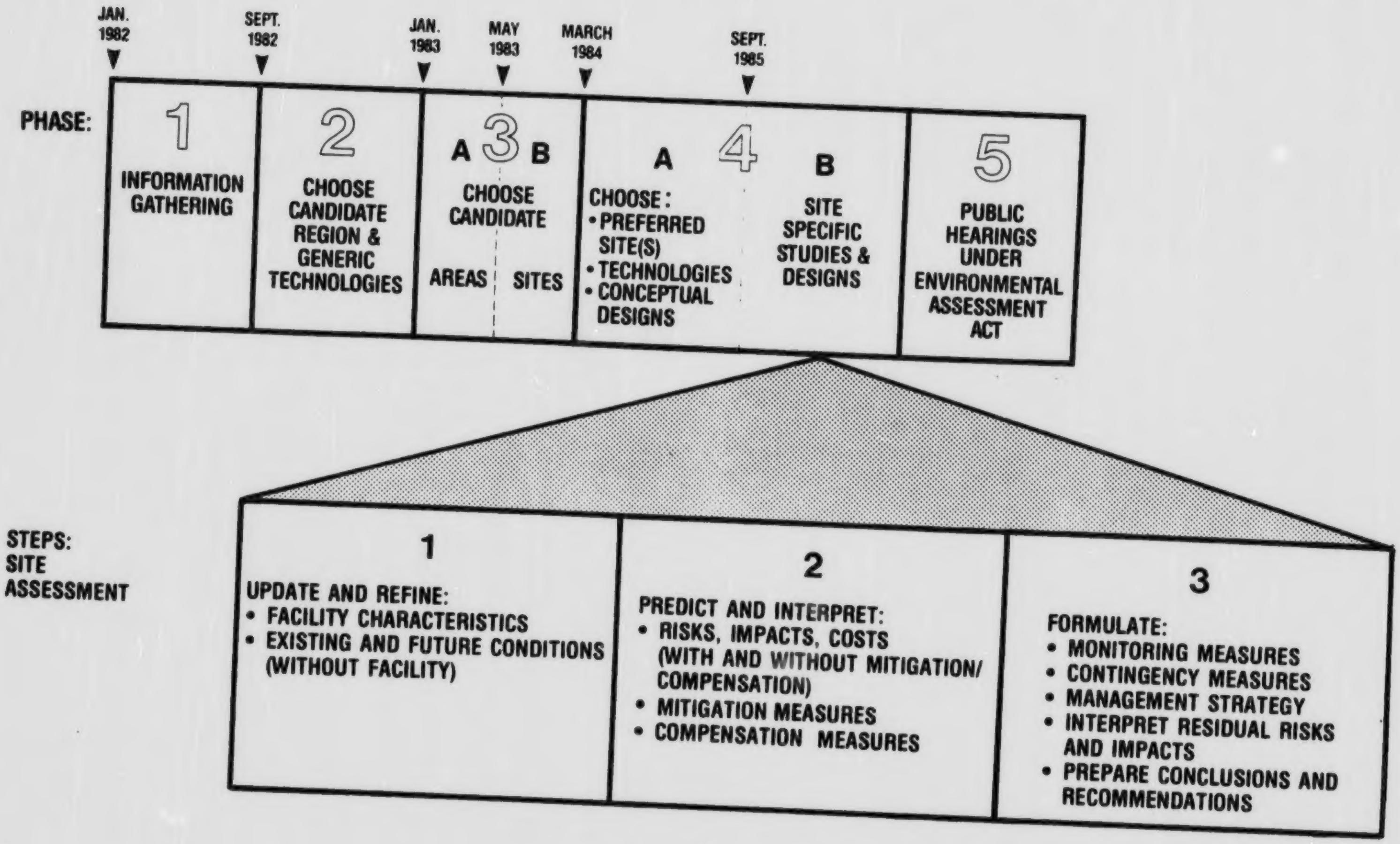
1.0 INTRODUCTION

1.1 PURPOSE OF THIS REPORT

This report documents the biological studies carried out as part of Phase 4B of the Ontario Waste Management Corporation's (OWMC) Facilities Development Process (Figure 1). Phase 4B involves detailed assessments of the preferred site and surrounding area based on several disciplines, including biology.

The specific objectives of Phase 4B are to:

1. Define the existing environmental conditions (baseline) of the preferred siting options;
2. Predict and assess potential risks and impacts that may be associated with the proposed facility design and operations;
3. Identify and develop appropriate mitigative measures to minimize the potential risks and impacts associated with the proposed facility design and operations;
4. To identify residual impacts which remain following the application of mitigation;
5. Identify and develop monitoring programs that will be implemented to assess the effectiveness of the design and operations in minimizing risks and impacts; and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A 4 B
CHOOSE :
• PREFERRED SITE(S)
• TECHNOLOGIES
• CONCEPTUAL DESIGNS
SITE SPECIFIC STUDIES & DESIGNS
5
PUBLIC HEARINGS UNDER ENVIRONMENTAL ASSESSMENT ACT
STEPS: SITE ASSESSMENT
1
UPDATE AND REFINE:
• FACILITY CHARACTERISTICS
• EXISTING AND FUTURE CONDITIONS (WITHOUT FACILITY)
2
PREDICT AND INTERPRET:
• RISKS, IMPACTS, COSTS (WITH AND WITHOUT MITIGATION/ COMPENSATION)
• MITIGATION MEASURES
• COMPENSATION MEASURES
3
FORMULATE:
• MONITORING MEASURES
• CONTINGENCY MEASURES
• MANAGEMENT STRATEGY
• INTERPRET RESIDUAL RISKS AND IMPACTS
• PREPARE CONCLUSIONS AND RECOMMENDATIONS

FIGURE 1
Facilities Development Process

6. Prepare documentation to meet the requirements of Ontario's Environmental Assessment Act.

For biology, the Phase 4B studies have focused on the preferred site, the site vicinity (lands contained within approximately 2 km of the site), a portion of the Welland River, and facility servicing corridors. Within these study areas consideration was given to describing existing biological conditions and predicting future biological conditions which might arise if the OWMC facility was not constructed.

Accordingly, this report:

- Documents the existing state of biological conditions, both on the preferred site and in the surrounding area, and describes future scenarios of possible changes which might result with and without the facility;
- Considers the biological component of the Phase 4A site selection process in relation to the enhanced level of data and design refinements available for Phase 4B and confirms the validity of siting comparisons made in Phase 4A.
- Documents the impacts on the biological resources of the area associated with development and operation of the proposed facilities, together with recommended mitigative measures and a monitoring program.

1.2 BACKGROUND

The Ontario Waste Management Corporation (OWMC) has been involved in a five-phase Facility Development Process (Figure 1).

This report deals with biological considerations addressed during Phase 4B of the Facilities Development Process.

During the previous phase of the process (Phase 4A), a preferred site (LF-9C) was identified. The location of this site is shown on Figure 2.

OWMC's three site selection goals are:

(1) to minimize risk to human health;
(2) to minimize environmental impact; and
(3) to minimize financial cost to OWMC and the people of Ontario.

The study of biological considerations in the site selection process contributes to the goal of minimizing environmental impacts.

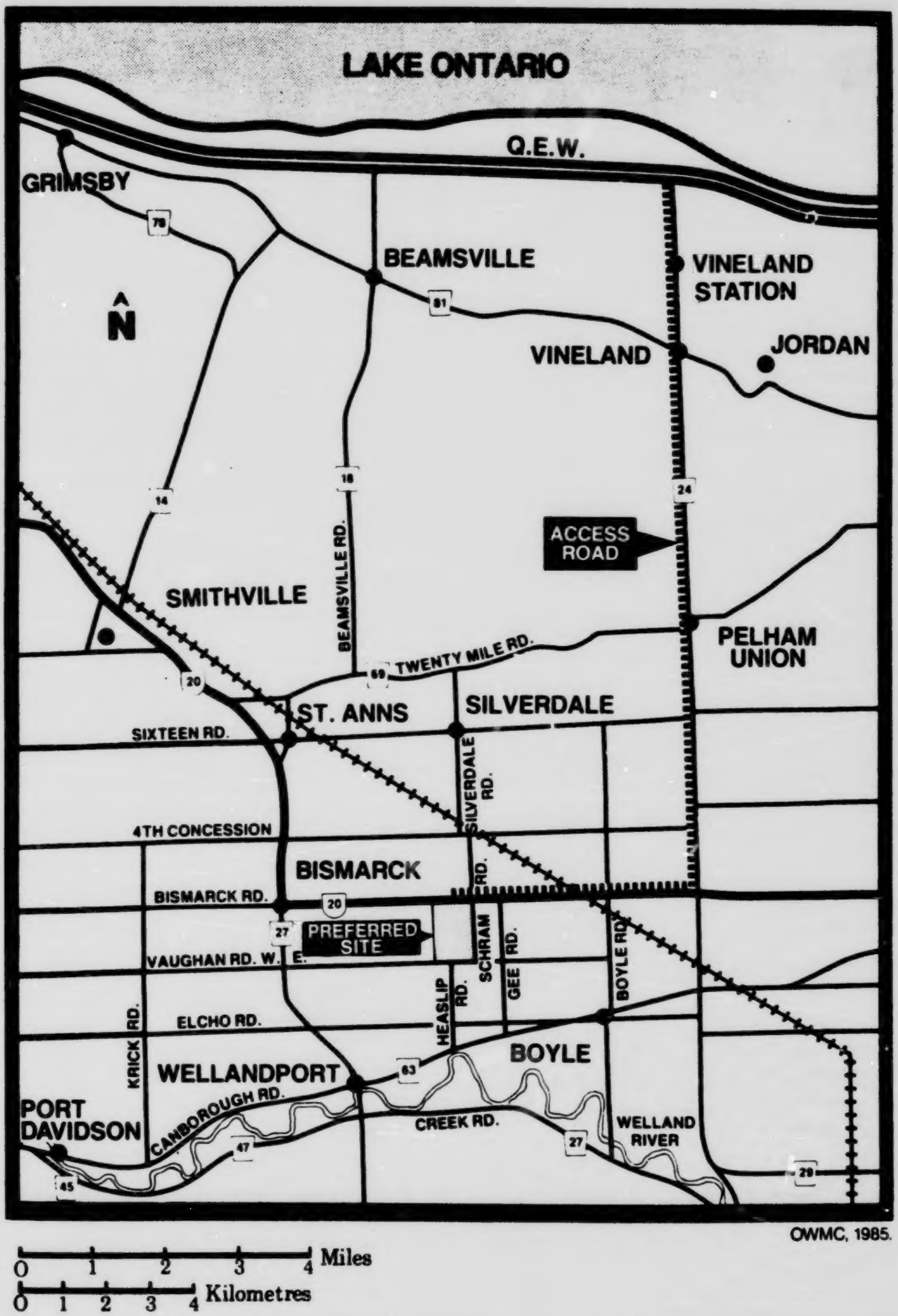
Figure 3 illustrates major components of the Phase 4B biology study process. These components are addressed in more detail in subsequent sections of the report.

1.3 SCOPE

The biology component of the Phase 4B study involves an assessment of the impacts associated with the proposed undertaking and a consideration of impact mitigation and monitoring.

This report also presents a description of the methods which were used in data collection and assessment and describes the existing biological conditions on the preferred site and vicinity. The description of existing conditions is largely

Township of West Lincoln, Regional Municipality of Niagara. Local Detail.


LAKE ONTARIO
Q.E.W.
GRIMSBY
79
BEAMSVILLE
81
VINELAND STATION
VINELAND
JORDAN
N
14
18
24
ACCESS ROAD
SMITHVILLE
BEAMSVILLE RD.
PELHAM UNION
TWENTY MILE RD.
69
20
ST. ANNS
SILVERDALE
SIXTEEN RD.
SILVERDALE RD.
4TH CONCESSION
BISMARCK
RD.
BISMARCK RD.
20
27
PREFERRED SITE
VAUGHAN RD. W.
E.
SCHRAM
RD.
GEE
BOYLE RD.
HEASLIP RD.
KRICK RD.
ELCHO RD.
BOYLE
WELLANDPORT
63
PORT DAVIDSON
CANBOROUGH RD.
CREEK RD.
47
27
WELLAND RIVER
45
29
0 1 2 3 4 Miles
0 1 2 3 4 Kilometres

OWMC, 1985.

Ontario Waste Management Corporation

Preferred Site

Figure 2

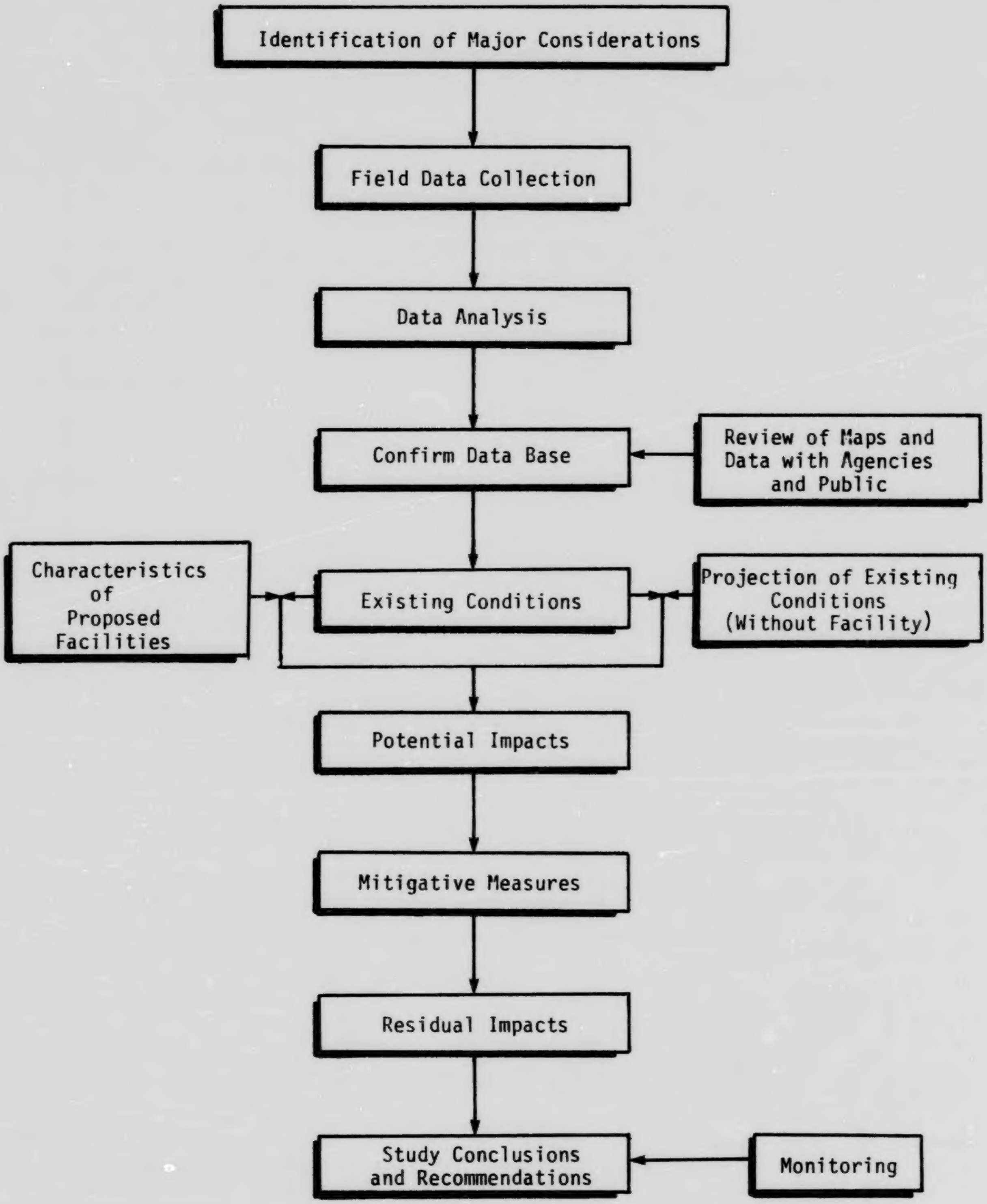

Identification of Major Considerations
Field Data Collection
Data Analysis
Confirm Data Base
Review of Maps and Data with Agencies and Public
Characteristics of Proposed Facilities
Existing Conditions
Projection of Existing Conditions (Without Facility)
Potential Impacts
Mitigative Measures
Residual Impacts
Study Conclusions and Recommendations
Monitoring

Figure 3
PHASE 4B BIOLOGY STUDY PROCESS

based on data collected during Phase 4B. Biological data gathered during Phases 3B and 4A were also reviewed and incorporated into this report where appropriate.

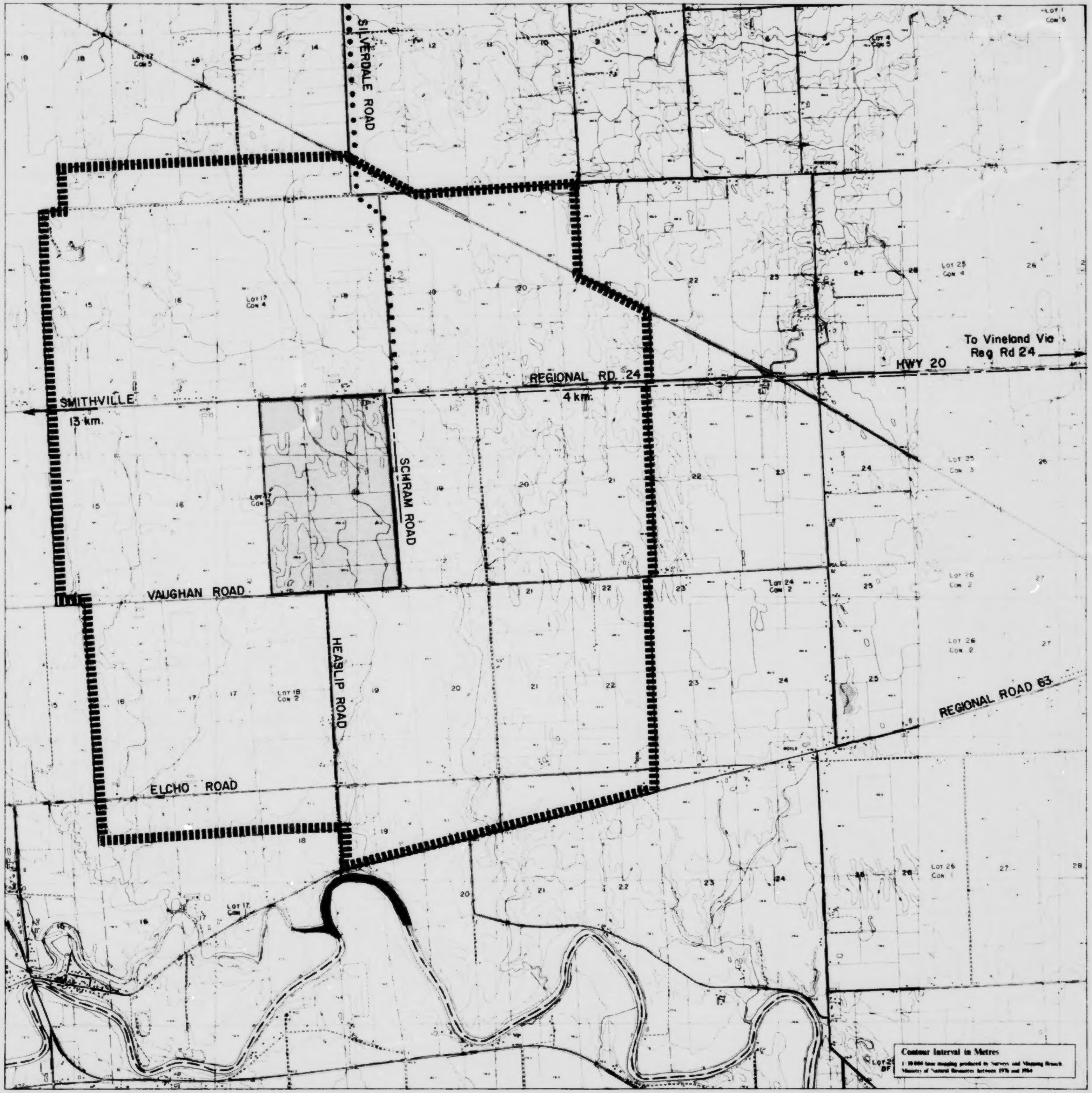
Potential impacts on the biological resources of the preferred site and adjacent lands associated with the construction and operation of the 300,000 t/a OWMC waste treatment facility are also addressed, and consideration is given to mitigative measures and monitoring.

Potential biological impacts associated with emissions from the incinerator and evaporator stacks and surface water effluent are addressed by Environ Corporation (1987), as part of the Environmental Risk Assessment.

1.4 STUDY AREAS

Study areas are referred to frequently throughout the report. As was the case in Phase 4A, the "site" and "site vicinity" study areas (Figure 4) were examined. The site boundaries were provided by OWMC, based on property acquisition limits determined at the end of Phase 4A. The preferred site is 124 ha in area. This is where the waste treatment and disposal facilities would be constructed.

The site vicinity surrounds the site and is an envelope approximately 2 km in radius from the centre of the site. A 2 km radius site vicinity study area was chosen for the purposes of the Phase 4A study, since it was expected that off-site biological impacts would be confined to this area. This assumption has not changed and accordingly, the size of the site vicinity study area was retained for the purposes of the Phase 4B study.


SILVERDALE ROAD
REGIONAL RD. 24
4 km.
To Vineland Via Reg Rd 24
HWY 20
SMITHVILLE
13 km.
SCHRAM ROAD
VAUGHAN ROAD
HEASLIP ROAD
REGIONAL ROAD 63
ELCHO ROAD
LOT 17 CON 5
LOT 17 CON 4
LOT 17 CON 3
LOT 18 CON 2
LOT 17 CON 1
LOT 24 CON 2
LOT 25 CON 4
LOT 25 CON 3
LOT 26 CON 2
LOT 26 CON 1
LOT 4 CON 5
LOT 1 CON 6

Contour Interval in Metres

1:10 000 base mapping produced by Surveys and Mapping Branch Ministry of Natural Resources between 1978 and 1984

OWMC Ontario Waste Management Corporation

Consultant: Gartner Lee Limited

Legend:

Study Area

IIIIIIIII SITE VICINITY

☐ PREFERRED SITE

■ WELLAND RIVER

Facility Servicing Corridors

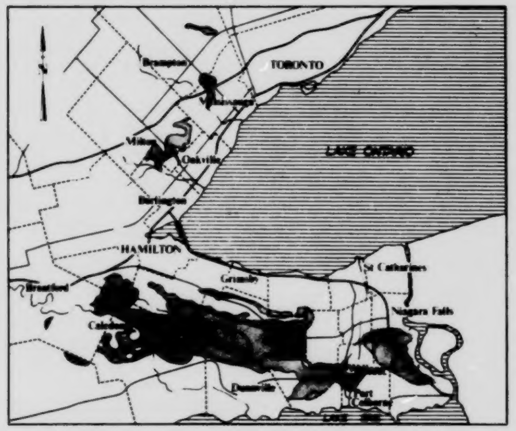
—··— PROCESS WATER

—·— NATURAL GAS

••••• HYDRO

Key Map: Preferred Site

Lot 18 and Part of Lot 17; Concession III; Township of West Lincoln; formerly in the Township of Gainsborough


TORONTO
Brampton
Mississauga
Milton
Oakville
LAKE ONTARIO
Burlington
HAMILTON
St Catharines
Grimsby
Brantford
Niagara Falls
Caledonia
Dunnville
Port Colborne
LAKE ERIE

1000 feet 0 1000
500 metres 0 500

Figure 4

Phase 4B Biology Study Areas

Two additional study areas were addressed during Phase 4B: facility servicing corridors and a portion of the Welland River (Figure 4).

Facility servicing corridors are areas within which services would be constructed and operated and include: potable water, storm water disposal, natural gas, and electricity.

"Make-up" water for treatment processes will be conveyed through a buried watermain and uncontaminated storm water runoff will be conveyed through a buried storm sewer, both of which will be constructed within the Heaslip Road right-of-way. This corridor extends south from the southern boundary of the site to a proposed pump house/outfall situated on the north bank of the Welland River and falls within the site vicinity study area.

Sewerage will be trucked from the site to an appropriate sewage treatment facility. Potable water will be trucked to the OWMC facility.

Natural gas will be provided by a buried pipeline extending from the Town of Vineland, south along Regional Road 24 to Highway 20, west along Highway 20 to Schram Road and south on Schram Road to the site access point. This route was selected following a preliminary evaluation by Consumers Gas (1987).

Electricity will be provided by a 115 kV wood pole line extending from the existing east/west Ontario Hydro 115/230 kV transmission line situated 3.0 km north of the site, south along the east side of Silverdale Road to the northeast corner of the site (at the intersection of Highway 20 and Schram Road). This was selected as the preferred route by Ontario Hydro (1987), following a comparative evaluation of alternative transmission routes to the site.

Approximately 1 km of the Welland River, from the mouth of Beaver Creek downstream to the mouth of an unnamed creek which drains the preferred site, was studied to determine its significance from a fisheries perspective.

1.5 TIME HORIZONS

Field data collection during Phase 4B was carried out over a 12-month period. This allowed a characterization of existing biological conditions on the site and in the site vicinity during all four seasons. Within this 12-month period, however, field work was concentrated during the spring and summer months (April to September) to correspond with the peak period of plant growth and animal activity.

Future scenarios of possible changes in existing biological conditions which might occur without the facility were projected over approximately a 20-year period, corresponding with the minimum life span of the landfill component of the OWMC facility. The rest of the facility may be in operation for a longer period.

Biological impacts, mitigative measures and monitoring programs of both short- and long-term duration were addressed in this study.

Time horizons associated with impacts, mitigation and monitoring were identified where possible (see Section 5.4). Those considered to be of long-term duration often extended beyond the minimum 20-year life span of the landfill component of the OWMC facility.

1.6 FACTORS AND INDICATORS

Two biological impact factors, (1) impacts on ecosystem structure and (2) impacts on ecosystem function were selected to focus the impact analysis. These factors differ from those used in previous phases of the OWMC Site Selection Process. In Phase 4A, biological factors were used in the comparative evaluation of siting options. The factors employed in Phase 4B have been derived to provide the organizational framework within which biological impact data are presented and analyzed. Definitions, rationale and the significance of each impact factor are described in Section 5.4 of this report.

Each biological impact factor has been subdivided into three impact indicators. Indicators represent more specific components/aspects of the impact factors and allow biological impacts to be identified and described in a more precise manner. The biological impact factors and impact indicators used in Phase 4B are listed below:

BIOLOGICAL IMPACT FACTORS	BIOLOGICAL IMPACT INDICATORS
A. Impacts on Ecosystem Structure	1. Rare and Significant Species 2. Plant and Animal Community Structure and Representativeness 3. Plant and Animal Habitat Area
B. Impacts on Ecosystem Function	1. Ecosystem Efficiency 2. Ecosystem Stability 3. Ecosystem Resilience

1.7 LIMITATIONS

Field data are available for a one-year (1986) period, augmented by preliminary biological information on the preferred site and vicinity gathered during Phase 4A (Gartner Lee Associates Limited 1985a). Since biological systems are known to be dynamic, certain animal species may vary in their presence or absence, distribution, and abundance from year to year. The results of the Phase 4B biology study provide a "window" on the biological conditions which prevailed during the 1986 field season. Continued monitoring of baseline conditions prior to facility construction will provide an indication of environmental change.

Predicting impacts on biotic resources often lies within the realm of professional judgement. Quantifying such impacts is also difficult to do with certainty due to 1) the highly complex nature of cause and effect relationships among elements of the ecosystem and, 2) the high degree of chance events occurring within an ecosystem.

However, a monitoring program has been recommended in Section 8.0, the intent of which is to identify changes in certain elements of the natural environment, not only prior to facility construction but also during the operations and post-operations stages. Thus, natural changes which develop prior to construction and project-induced changes which result during construction and operation of the OWMC facility would be identified and appropriate steps could be taken to modify facility operations or to design mitigative measures, as required.

Although no formal meetings or interviews to discuss biological issues were held with local landowners/tenants during Phase 4B, several area residents provided biology-related information during conversations with GLL biologists and during a water well survey conducted by a GLL hydrogeologist. This information served to augment that which was obtained from local landowner contacts made during Phase 4A.

However, none of the limitations noted above is thought to interfere with meeting the objectives of the Phase 4B biology study, listed in Section 1.3. Information obtained and relied upon during Phase 4B is adequate for characterizing existing conditions, for predicting potential impacts, for recommending appropriate mitigative measures, and for identifying potential residual impacts. Although further study would serve to amplify this information, it is not expected to alter the conclusions of this report.

1.8 ROLE OF THE PUBLIC AND AGENCIES

The public was invited to review Phase 4A documentation and to review Phase 4B methods. The public was also given the opportunity to contribute input of a technical nature (e.g., comments on their knowledge of wildlife and vegetation in the study areas). Contacts with the public were made via OWMC publications and open houses (OWMC 1987) and discussions were held with some property owners during field work.

Local naturalists, anglers, and a trapper were contacted during Phase 4B and provided pertinent biological information which had been collected during 1986 and/or the recent past.

The Ontario Ministry of Natural Resources (OMNR) was contacted early in Phase 4B. The proposed biology field protocol (GLAL 1986) was provided to OMNR for their review.

All public and agency contacts made during Phase 4B are listed in Appendix A of this report.

2.0 DATA COLLECTION METHODS

2.1 EXISTING DATA

Prior to conducting detailed field investigations a review of existing biological information gathered during previous phases of the Site Selection Process was carried out. These data are contained in GLL files and are summarized in "Site Selection Process Phase 4A: Technical Appendix LF-9C - Existing Biological Conditions" (GLAL 1985a).

The primary sources of information relied upon during Phase 4A of the study included the following:

- primary data base assembled during previous phases of the study;
- scientific literature;
- published and unpublished reports, maps and "open file" reports;
- Interviews with government agency personnel, local residents, naturalists and trappers, and
- on-site field surveys.

Since Phase 4B data are intended to assess and refine the results of the Phase 4A study, Phase 4A data have been incorporated into the present report, where applicable.

2.2. MINISTRIES AND AGENCIES

Discussions with Regional Municipality of Niagara, Ontario Ministry of Natural Resources (Niagara District), and Ontario Hydro personnel were conducted during Phase 4B to gather additional information regarding the biological resources of the site, site vicinity, service corridors and the Welland River. Deer census, forestry resource and wetland evaluation data contained in OMNR Niagara District files were reviewed and information regarding natural areas of the Niagara Region were provided by the Regional Municipality of Niagara. Additional locations of a rare plant species were provided by Ontario Hydro.

2.3 PUBLIC AND SPECIAL INTEREST GROUPS

Requests for information pertaining to the biological resources of the site and the site vicinity were made to representatives of special interest groups and naturalist clubs, knowledgeable field naturalists and local experts (Appendix A).

Responses were received from several individuals who participated in the Ontario Breeding Bird Atlas Project. Recent information (gathered since the completion of Phase 4A) concerning utilization of the site and site vicinity study areas by breeding birds were provided.

Botanical experts at the National Museum of Natural Sciences in Ottawa, the New York State Museum in Albany, New York, the Buffalo Museum of Natural Sciences in Buffalo, New York, the University of Guelph, and the University of Toronto (Erindale College) were contacted to determine the significance and status of various plant species and to verify the identification of selected specimens collected during the vegetation study.

Information regarding the fisheries resources of the Welland River was provided by the curator of the Department of Herpetology and Ichthyology, Royal Ontario Museum and a faculty member in the Department of Biological Sciences, Brock University, St. Catharines. Staff in the Department of Mammalogy of the Royal Ontario Museum assisted in determining the identification of small mammal specimens collected during the mammal study.

Several area residents provided biology-related information during conversations with GLL biologists and during a water use and water well survey conducted by a GLL hydrogeologist.

The contributions of these individuals and groups are acknowledged in Section 11.0 and the information sources provided are cited in Section 12.0 of this report.

2.4 FIELD DATA COLLECTION METHODS

2.4.1 VEGETATION - SITE AND VICINITY

The botanical component of the Phase 4B biology study addressed three main objectives:

- to document the presence of rare plant species, including those previously identified in Phase 4A;
- to collect and analyze data which provide a characterization of the vegetation resources of the site, site vicinity and facility service corridors; and

- to assess the potential impacts of the proposed OWMC facility on the botanical resources of the site, site vicinity, and facility servicing corridors.

Botanical field studies were carried out in the site and site vicinity study areas during three separate periods in 1986: spring, mid-summer and late summer. Trees growing in road right-of-ways along facility servicing corridors were studied in February, 1987.

Initial botanical investigations were conducted in mid-May, 1986 to coincide with the flowering of spring ephemerals and to confirm the homogeneity of the vegetation communities mapped in Phase 4A. The bulk of the botanical data was collected in July, 1986 when the majority of plants are in bloom. Visits were made in late August and early September, 1986 to record the presence of late flowering plant species.

Tree data were collected using the Point-centred Quarter Analysis (Curtis 1959; Mueller-Dombois and Ellenberg 1974). This technique provides a quantitative characterization of the vegetation of a given area and involves sampling the trees and ground vegetation contained within four quadrants about randomly selected points. Each point was tagged to facilitate relocation. These data allow a determination of tree species presence and provide a measure of relative density, relative dominance, relative frequency and importance. A detailed description of the Point-centred Quarter Analysis technique and a rationale for its use is provided in Appendix B.

Point-centred Quarter Analysis was applied to 15 representative homogeneous units, six on the preferred site, seven within a 500 m radius of the site, and two in the remaining site vicinity study area. The locations of these stands are shown in Figures 5 and 6 (back pocket). Site vicinity field work was concentrated within a 500 m radius of the site, since most of the potential impacts on botanical resources were expected to occur in this portion of the site vicinity study area.

In addition to quantitative data collection, qualitative observations were made in three other wooded complexes. Non-wooded vegetation communities were also sampled in a semi-quantitative fashion. On both the site and in the site vicinity, one unit each of thicket, marsh, old field and recently disturbed field was selected for vegetation analysis (see Figures 5 and 6). Ten evenly spaced 1 m^2 quadrants were placed along a randomly selected transect. In each quadrant an estimate of percent cover by each plant species was made.

An attempt was made to identify all plant species encountered while conducting field work. In cases where positive identification could not be made in the field, a specimen was collected. Plant specimens were collected in accordance with the technique described by Savile (1962) (see Appendix B).

Direct observations of wildlife, topographic features, and human and natural impacts were also made during the course of the vegetation field work.

2.4.2 WILDLIFE - SITE AND VICINITY

The wildlife component of the Phase 4B biology study addressed three main objectives:

- to collect and analyze data which provide a characterization of the wildlife communities (species composition, relative density and distribution) which utilize the site and site vicinity;

- to document the presence of rare species and significant habitats; and

- to assess the potential impacts of the proposed OWMC facility on the wildlife resources of the site and site vicinity.

A variety of data collection methods was employed in the field, depending upon the particular life form being studied. A more detailed discussion of these data collection methods and the rationale for their use are provided in Appendix B. Investigations of the following wildlife communities were carried out: winter birds, breeding birds, mammals, reptiles and amphibians, and butterflies.

Winter bird populations were sampled on two occasions in February, 1986 using a census technique adapted from the Audubon winter bird-population study (Kolb 1965; Robbins 1972). This involved traversing the site along grid lines spaced at 100 m intervals and plotting the locations of all birds seen or heard.

Breeding bird populations on the site and in the site vicinity were sampled using the spot-mapping method (Williams 1936; Kendeigh 1944). This sampling technique allows a determination of the number of territories of each species in a given study plot, a value from which the relative density of breeding pairs may be derived. Five plots were sampled, three woodland

and two field (see Figures 5 and 6 for locations). The methodological procedure that was followed is described in detail in Appendix B.

Each study plot was censused on six occasions from late May to mid-July, 1986. Observations of birds outside the five census plots were recorded and locations noted on base maps of the site and site vicinity.

An aerial survey of the site and site vicinity was conducted on July 21, 1986. The primary objective of this survey was to confirm the location of a reported nesting colony of Great Blue Herons (Ardea herodias) in the area. This involved flying over the site and site vicinity study areas in a systematic fashion.

Small mammal populations were sampled using a combination of "Museum Special" snap traps and pitfall traps. Employing both types of traps optimized the chances of capturing both microtines (mice and voles) and insectivores (shrews), thereby obtaining a representative sample of the small mammal community. The census techniques used were adapted from Nagorsen and Peterson (1980) and are described in detail in Appendix B.

Three relatively homogeneous habitat types were sampled: upland forest ridges, lowland forest sloughs, and the interface ("edge") between forest and fallow field/pasture.

Five transects were established (see Figures 5 and 6 for locations) and trapped for three successive nights, once in early August and again in early September, 1986. Traps were checked early in the morning following each trap night.

The results of the small mammal study enabled an estimation of the relative abundance of species in a variety of habitat types based on the number of captures per trap night. It also provided information concerning the composition of the resident small mammal population and habitat utilization.

The presence of larger mammals was documented through direct observations and evidence (e.g., tracks, scats, road kills). Two visits were made in February, 1986 to determine the direction and intensity of White-tailed Deer (_Odocoileus virginianus_) movements on the site using track counts.

The occurrence of reptiles and amphibians (herpetofauna) was recorded throughout the duration of the wildlife study. Chorusing frogs and toads and breeding amphibious salamanders were searched for in wet, low-lying areas during the spring. These species lay their eggs in shallow water of temporary or permanent ponds.

Woodland salamanders, turtles and snakes were searched for in suitable habitat. Unlike amphibious salamanders, woodland salamanders lay their eggs on land, in moist habitats. They are typically found under rocks or rotting logs. Turtles frequent bodies of open water and snakes are often found under flat objects such as plywood or shingles. This provided qualitative information concerning species composition and habitat utilization.

Records of butterfly observations were kept concurrent with the breeding bird, small mammal, and herpetofaunal surveys. Selected individuals were collected in order to allow verification of species identity. Specimens were prepared according to the standard specifications for institutional collections (Martin 1977). These observations provided data concerning species composition, habitat preferences, and flying times of adult butterflies.

Evidence of wildlife resource use (e.g., hunting, trapping) and existing impacts (e.g., human disturbance, habitat removal) were also documented throughout the field season.

2.4.3 FISHERIES - SITE AND VICINITY

The fisheries component of the Phase 4B biology study addressed six main objectives:

- to verify the presence or absence of Northern Pike (*Esox lucius*) and other fish species and to confirm their spawning activity and reproductive condition in an unnamed creek (hereafter referred to as 9C Creek) and Beaver Creek, both of which drain into the Welland River;
- to assess the significance of these spawning runs from a regional and local perspective;
- to characterize the structure and composition of the fish communities inhabiting these watercourses and their utilization of aquatic habitats;
- to characterize instream habitat (particularly critical life history habitat) along the Welland River and at the mouths of 9C Creek and Beaver Creek;
- to document the presence of rare fish species; and

- to assess the potential impacts of the proposed OWMC facility on the fisheries resources of downstream watercourses.

Fish populations inhabiting the Welland River immediately downstream of the mouths of 9C Creek and Beaver Creek were sampled on four occasions in early April, early June mid-August, and late September, 1986. Sampling over a six-month period allowed the identification of changes in fish species composition and abundance. Fish populations inhabiting 9C Creek and Beaver Creek were sampled using minnow traps in mid-August, 1986. Locations of fish sampling stations are indicated on Figure 6.

Two gangs of gill nets were used to sample fish in the Welland River and at the mouth of Beaver Creek, each consisting of eight, 16 m long panels. Mesh sizes ranged from 38 to 127 mm. All fish captured were identified to species, measured for length, weighed, and examined to determine sex, age and reproductive condition.

The type and quantity of aquatic habitat along these watercourses were surveyed during the April 3 and August 11, 1986 fish sampling visits. Stream assessment techniques and procedures for recording data and the handling of fish specimens were adapted from the OMNR document entitled Manual of Instructions: Aquatic Habitat Inventory Surveys (Dodge et al. 1985) (see Appendix B).

2.5 DATA INPUTS/OUTPUTS

This section of the report briefly describes 1) data inputs received from OWMC and other Site Assessment consultants and incorporated into the Phase 4B biology study and 2) data outputs generated by the Phase 4B biology study. The arrows linking the two columns indicate the data outputs which evolved from each data input. Data inputs/outputs are listed below:

DATA INPUTS		DATA OUTPUTS
● Information contained in other OWMC consultant reports which assisted in biological impact assessment (facility characteristics - Monenco Ltd. (1987a); design and operations - Monenco Ltd. (1987b); surface water drainage - M.M. Dillon Ltd. (1987a); transportation - M.M. Dillon Ltd. (1987c); berm revegetation - E.D.A. Collaborative Inc. (1987); agriculture - Ecologistics Ltd. (1987)).	⟷	● Biological information provided to other OWMC consultants to assist in their impact assessments (facility design and operations - Monenco Ltd. (1987b); visual impacts - E.D.A. Collaborative Inc. (1987); transportation - M.M. Dillon Ltd. (1987c)).
● Information contained in Ontario Hydro's (1987) environmental assessment of alternative hydro transmission routes	⟷	● Biological information provided to Ontario Hydro to assist in its environmental assessment

DATA INPUTS		DATA OUTPUTS
• OWMC consultant workshops, public consultation meetings	➡	• Biological component of report entitled Background Material for the Ontario Waste Management Corporation Phase 4B Public Consultation Site Assessment Meetings (OWMC 1987a)

3.0 EXISTING CONDITIONS

3.1 INTRODUCTION

This section of the report describes the existing biological conditions on the preferred site, in the site vicinity study area, along facility servicing corridors and in a small portion of the Welland River. The results of the vegetation, wildlife, and fisheries field data collection activities are summarized in three subsections, each dealing with a separate biological discipline (i.e., vegetation, wildlife, fisheries). Where appropriate, the data are presented in tabular form and on maps.

Locations of the sampling stations used for data collection and significant findings of the Phase 4B field work are noted on maps of the site and site vicinity.

These maps include the locations of rare species, significant environmental units, and significant fish and wildlife features (e.g., heronries, fish spawning areas).

Master species lists of plants, birds, mammals, reptiles and amphibians, fish, and butterflies are included as appendices to this report. A glossary of biological terms used in the report is included as Appendix M.

3.2 VEGETATION

A discussion of vegetation on and adjacent to the site, and how it relates regionally and provincially is presented. The analyses are supported by figures throughout the text, as well as data contained in Appendices C, D, E and F. Definitions of vegetation cover types are included as Appendix N.

3.2.1 REGIONAL VEGETATION

Vegetation patterns in the study area are strongly influenced by the geographical setting of the region and physical conditions on the site.

This portion of the Niagara Peninsula occurs within the Niagara Section of the Deciduous Forest Region, the most southern forest cover type in Canada. It possesses elements of both the Deciduous Forest Region and the Great Lakes - St. Lawrence Forest Region to the north (Rowe 1972).

The characteristic tree association in the area is dominated by American Beech (*Fagus grandifolia*) and Sugar Maple (*Acer saccharum*). Red, White and Bur Oaks (*Quercus rubra*, *Q. alba*, *Q. macrocarpa*) also occur commonly.

From a physical perspective, the site and vicinity vegetation patterns are controlled by a broad glaciolacustrine lake plain commonly referred to as the Haldimand Clay Plain. The poorly drained surface soils in that feature range from clayey silt to silty clay (Chapman and Putnam 1984).

The clay plain is relatively flat, with the only relief being minor ridges and swales. These ridges and swales are aligned generally north-northwest to south-southeast. This pattern influences the distribution of upland and lowland vegetation communities.

3.2.2 SITE VEGETATION

The bulk of the 124 ha site has been cleared of forest. Apart from agricultural crop and pasture lands, there is a mosaic of dry-mesic, mesic and wet-mesic forest, lowland thicket, marsh, old and recently disturbed fields. The approximate areas of each cover type are given in Table 1 and their spatial distributions are depicted on Figure 7 (back pocket). The boundaries of each vegetation type are dependent upon current agricultural practices and consequently the figures in Table 1 may fluctuate yearly. Of the 441 plant species reported in Phases 4A and 4B from the site and vicinity combined (Appendix C), 381 were recorded on the site.

3.2.2.1 Forest

Tree cover is concentrated in the northwest quadrant of the site. The 6 ha (5%) of the site with forest cover are represented by one large wooded block and several smaller ribbons of woodlot (Figure 7).

The forest on-site is represented on Figure 5 (back pocket) as a number of distinct parcels, known as stands. Each stand has been identified on the basis of differences in soil moisture and tree dominants. A comparison of the characteristics of each of the six on-site stands studied quantitatively is presented in Table 2. The six stands range from dry-mesic to mesic to wet-mesic conditions. Mesic and dry-mesic stands are dominated by Sugar Maple, Red Oak and White Ash (*Fraxinus americana*). Dominant trees in the wet-mesic stands include Red and Silver Maple (*Acer rubrum*, *A. saccharinum*), White Ash, White Oak, and Swamp White Oak (*Quercus bicolor*). The understory and ground cover components of the six forest stands are generally sparse. Disturbances are restricted to scattered logging activities.

Table 2 compares several basic characteristics including stand type, size, dominant tree species, importance value, number of trees per hectare, and average diameter at breast height (dbh). Although definitions of these terms are provided in the Glossary (Appendix M), a brief discussion of them is presented below to assist in an interpretation of Table 2.

TABLE 1 : AREAL EXTENT OF VEGETATION COVER TYPES ON THE PREFERRED SITE

VEGETATION COVER TYPE *	APPROXIMATE AREA (ha) **	PERCENT OF TOTAL AREA (%)
Natural Vegetation		
dry-mesic forest	1	1
mesic forest	3	2
wet-mesic forest	2	2
thicket	1	1
recently disturbed field	42	34
old field	4	3
marsh	7	6
Other		
cropland	63	50
unclassified	1	1
Total	124	100

NOTES :

* Definitions of each cover type are contained in Appendix N

** Areas are approximate and are rounded to whole numbers

TABLE 2 : SUMMARY OF PREFERRED SITE STAND CHARACTERISTICS

STAND NO PARAMETER	1	2	3	4	5	6
STAND TYPE	dry - mesic deciduous woods	mesic deciduous woods	wet - mesic deciduous woods	wet - mesic deciduous woods	wet - mesic deciduous woods	mesic deciduous woods
APPROXIMATE SIZE (ha)	1	3	1	1	< 1	< 1
TREE DOMINANTS (importance value)	Acer saccharum (95) Quercus rubra (54)	Quercus rubra (66) Acer saccharum (61)	Acer saccharinum (83) A. rubrum (71) Fraxinus americana (41)	Acer rubrum (50) Quercus alba (44)	Quercus bicolor (95) Fraxinus americana (49) Quercus alba (41)	Fraxinus americana (88) Quercus rubra (41) Acer saccharum (38)
NUMBER OF TREES PER HECTARE (TREES / ACRE)	854.62 (346)	1076.92 (436)	713.83 (289)	857.09 (347)	921.31 (373)	1158.43 (469)
AVERAGE DIAMETER AT BREAST HEIGHT cm (inch)	22.99 (9.05)	20.04 (7.89)	40.49 (15.94)	27.0 (10.63)	28.70 (11.3)	26.57 (10.46)

Stand type classifies the woods by both type of trees present (deciduous, mixed or coniferous) and by soil moisture. All stands investigated were deciduous or dominated by broad-leaved species. The moisture regime used to classify stands is based on a relative scale ranging from dry to mesic to wet, with combinations of these three terms as intermediate conditions.

Tree dominants indicate which species are most prevalent in a particular stand. This could be an indication of greater frequency, increased density or larger size. The importance value (i.e., the importance of the species relative to other species in the stand) associated with each species is a value calculated from a total possible score of 300. It provides an indication of the degree of importance, whereby the higher the value, the more dominant a particular species is in a stand (see Appendix D).

Two other features provide a comparison of the structural aspects of each stand. Number of trees per hectare denotes the density of stems, with a higher value indicative of a more crowded stand, while average dbh refers to the average diameter of the stems present (at a height of 1.5 m from the tree base). The higher the value, the larger the specimens present in the stand. Both provide some indication of the age of a particular stand.

Dry-mesic

One dry-mesic stand (Stand 1) occurs on-site (Figure 5). It is located on the east side of the largest forested block on-site and represents approximately one-quarter of the area of that woodlot. It is the driest stand and the only one dominated by Sugar Maple. This species has an importance value of 95 in Stand 1. Red Oak is co-dominant, with an importance value of 54. A number of less dominant tree species occur; these include Red Maple, American Beech and White Ash, all with importance values of around 20. Several other minor tree species were recorded in the stand, including Black Cherry (*Prunus serotina*) and White Pine (*Pinus strobus*).

Maple-leaved Viburnum (*Viburnum acerifolium*) and Poison Ivy (*Rhus radicans*) had the highest percent cover values of all of the non-tree species in this stand. Cover values for these two species were 0.1 and 0.7%, respectively. As these values suggest, vegetation in the understory and ground cover strata is sparse.

The only recent disturbance apparent in this stand is some selective logging. The removal of trees was facilitated by small logging trails situated throughout.

Mesic

Stands 2 and 6 (Figure 5) are examples of mesic woods.

Forming the bulk of the on-site woods (3 ha), Stand 2 is dominated by Red Oak and Sugar Maple. The importance values for these two species are relatively similar, 66 and 61, respectively. Three less dominant tree species are present, with importance values in the low to mid-20s. They include American Elm (*Ulmus americana*), Basswood (*Tilia americana*), and Red Maple.

The understory and ground cover strata are relatively more rich than in Stand 1. The species with the largest percent cover are Running Strawberry Bush (Euonymus obovatus), Witch Hazel (Hamamelis virginiana), Large-leaved Aster (Aster macrophyllus) and Flat-topped White Aster (A. umbellatus).

Of all the stands on-site, Stand 2 has the smallest average dbh for its trees (20.04 cm) and the second largest number of stems per hectare (see Table 2). This suggests that the trees are younger than those growing in other on-site stands.

Stand 6 is dominated by White Ash, Red Oak and Sugar Maple, with importance values of 88, 41 and 38, respectively. Shagbark Hickory (Carya ovata), Basswood and Red Maple have importance values in the mid- to upper 20s.

The most prevalent ground cover and understory species in Stand 6 are Running Strawberry Bush, Hairy Sweet-cicely (Osmorhiza claytoni), Spotted Jewelweed (Impatiens capensis) and Red Raspberry (Rubus idaeus var. strigosus).

Stand 6 has the largest number of stems per hectare and an intermediate average basal area. Adjacent to and southwest of Stand 6 there is a small portion of woods which has recently been heavily cut over (Figure 5).

Wet-mesic

Although Stands 3, 4, and 5 are all examples of wet-mesic forest, they vary in composition and structure (Table 2).

The dominant trees in Stand 3 are Silver Maple, Red Maple and White Ash. They have importance values of 83, 71 and 41, respectively. Other species, including American Elm and Swamp White Oak, are present to a lesser extent.

The widely spaced, mature character of this stand is illustrated in Table 2. Stand 3 has the fewest number of trees/ha with the largest average dbh among all the on-site woodlots examined.

The ground flora stratum is relatively dense, except in the centres of swales subject to more continuous flooding. Collectively, five ground cover species provide an average cover of 25% in this stand. They are Spotted Jewelweed, Virginia Creeper (Parthenocissus vitacea), Running Dewberry (Rubus pubescens), Hog Peanut (Amphicarpa bracteata) and Michigan Lily (Lilium canadense var. michiganense).

Stand 4 (1 ha) includes the bulk of the smaller woods in the northwest corner of the site (Figure 5). It is dominated by Red Maple and White Oak, with importance values of 50 and 44, respectively. Four other tree species with relatively high importance values are Swamp White Oak, Shagbark Hickory, White Ash and Trembling Aspen (Populus tremuloides). The ground flora stratum in Stand 4 includes a relatively high percent cover of Spotted Jewelweed.

Stand 5 is a small unit occupying less than 1 ha, situated in a low swale along the western edge of the site (Figure 5). It is the only stand encountered during the Phase 4B study in which Swamp White Oak is the dominant overstory species. The importance value of this species is 95. White Oak, Shagbark Hickory and White Ash are also present, with importance values of 41, 36 and 49, respectively.

Stand 5 has an average dbh of 28.70 cm, the second largest value attained among the wooded stands on-site (Table 2).

Rough Dogwood (*Cornus obliqua*) and Choke Cherry (*Prunus virginiana*) are present, with average cover values of 31.3 and 17.5%, respectively. The understory is more dense in this stand than in any other wooded stand on-site.

3.2.2.2 Thicket

One thicket cover type (Stand 6a) was quantitatively sampled on the site (Figure 5). Contained by a seasonally wet swale, this thicket is dominated by the tall, woody shrub, Buttonbush (*Cephalanthus occidentalis*).

Other species frequently encountered include Marsh Fern (*Thelypteris palustris*), Marsh St. John's-wort (*Triadenum fraseri*) and Climbing Nightshade (*Solanum dulcamara*).

Narrow-leaved Meadowsweet (*Spirea alba*), an erect shrub usually less than 1.5 m tall, dominates other thicket areas on the site where Buttonbush does not occur. Meadowsweet appears to be the dominant shrub growing in open thickets, away from the influence of forest canopy.

3.2.2.3 Marsh

The 7 ha (6%) of marsh vegetation on the site are confined to numerous scattered swales and small ponds concentrated in the eastern half (Figure 7) . While qualitative observations were made in several of these swales, only one, Stand 10, was sampled in detail (Figure 5).

The dominant species in Stand 10 are Narrow-leaved Cattail (*Typha angustifolia*), Water-plantain (*Alisma plantago-aquatica*), Devil's Beggar-ticks (*Bidens connata*) and Broad-fruited Bur-reed (*Sparganium eurycarpum*). The boundaries of the marsh (Figure 7) appeared to vary between Phases 4A and 4B, as a result of changing agricultural practices and the ease of access to certain areas by agricultural machinery.

3.2.2.4 Field

Several examples of recently disturbed fields and smaller pockets of old field occur on the site (Figure 7). While qualitative observations were made in most, only one representative example of each type was sampled in detail.

Old field

Stand 8, an old field near the northwest corner of the site (Figure 5), is dominated by several native goldenrod species (e.g., *Solidago canadensis*, *S. altissima*, *Euthamia graminifolia*). The 4 ha (3%) of old field, including Stand 8, occur in the northwest quadrat of the site (Figure 7).

Recently disturbed field

Forty-two ha (34%) of this cover type are scattered throughout the site (Figure 7). The dominant plant species are primarily aggressive, non-native grasses and herbs including Timothy (*Phleum pratense*) and Bird's-foot Trefoil (*Lotus corniculatus*).

3.2.3 SITE VICINITY VEGETATION

As with the site, the site vicinity study area is characterized by a mosaic of agricultural land and natural vegetation, including forest, thicket, marsh, and field.

3.2.3.1 Forest

The bulk of the forested lands in the site vicinity occurs northwest, north and northeast of the site. These areas include large blocks of woods such as Silverdale Woods and Sucker Creek Woods (see Section 3.5.1). The pattern of shallow ridges and swales described in Section 3.2.1 is also evident in the site vicinity.

Appendix C lists the 290 plant species encountered in the site vicinity in Phases 4A and 4B.

Several woodlots were studied in the site vicinity. Within these woodlots, nine distinct parcels or stands were quantitatively investigated (Figure 6, back pocket). These stands have been classified on the basis of differences in soil moisture and tree dominants.

Of the nine stands, seven are situated within 500 m of the site boundary. The remaining two are located in the Silverdale Woods approximately 1.75 km from the site boundary. Other woodlots in the site vicinity were qualitatively studied (Figure 6).

A comparison of the vegetational composition of the nine stands is presented in Table 3. The parameters used in this comparison are the same as those used for the site stand comparison, as described in Section 3.2.2.1. The nine stands include a range of soil moisture conditions from dry-mesic to mesic to wet-mesic. In dry-mesic situations, Sugar Maple, American Beech and Red and White Oak dominate the overstory stratum. Mesic situations are also dominated by these species, as well as White Ash and Basswood. Wet-mesic stands are dominated by Red Maple and White Ash.

Dry-mesic

Two stands in the vicinity have been classified as dry-mesic,

TABLE 3 : SUMMARY OF SITE VICINITY STAND CHARACTERISTICS

CHARACTERISTIC	STAND #				
	OS - 01	OS - 02	OS - 03	OS - 04	OS - 06
STAND TYPE	mesic deciduous woods	mesic deciduous woods	dry - mesic deciduous woods	mesic deciduous woods	mesic deciduous woods
APPROXIMATE SIZE (ha)	2	3	5	1	3
TREE DOMINANTS (importance value)	Fagus grandifolia (91) Acer saccharum (78)	Fagus grandifolia (84) Acer saccharum (69)	Acer saccharum (77) Fagus grandifolia (64)	Fagus grandifolia (60) Acer saccharum (57) Fraxinus americana (37) Tilia americana (35)	Acer saccharum (87) Quercus rubra (52)
NUMBER OF TREES PER HECTARE (TREES / ACRE)	896.61 (363)	857.09 (347)	750.88 (304)	647.14 (262)	807.7 (327)
AVERAGE DIAMETER AT BREAST HEIGHT cm (inch)	19.23 (7.57)	25.58 (10.07)	22.23 (8.75)	27.66 (10.89)	28.02 (11.03)

CHARACTERISTIC	STAND #			
	OS - 09	OS - 10	OS - 12	OS - 13
STAND TYPE	mesic deciduous woods	wet - mesic deciduous woods	dry - mesic deciduous woods	wet - mesic deciduous woods
APPROXIMATE SIZE (ha)	4	3	1	2
TREE DOMINANTS (importance value)	Quercus rubra (105) Acer saccharum (78)	Acer rubrum (97)	Quercus alba (76) Q. rubra (43)	Fraxinus americana (88) Acer rubrum (80)
NUMBER OF TREES PER HECTARE (TREES / ACRE)	928.72 (376)	810.16 (328)	755.82 (306)	531.05 (215)
AVERAGE DIAMETER AT BREAST HEIGHT cm (inch)	28.12 (11.07)	25.98 (10.23)	33.58 (13.22)	40.26 (15.85)

OS-03 and OS-12. Stand OS-03 (5 ha) is dominated by Sugar Maple and American Beech, with importance values of 77 and 64, respectively. Red Oak and Basswood are also relatively important.

The ground cover is sparse, with Garlic Mustard (*Alliaria alliaria*) providing the greatest cover, at 6.1 %. This stand has been subject to some recent tree cutting.

Stand OS-12, situated to the north of the site (Figure 6), is dominated by White and Red Oak, with importance values of 76 and 43, respectively. Both American Elm and Shagbark Hickory are also present in this small (1 ha) stand.

Black Snakeroot (*Sanicula gregaria*) and Downy Arrow-wood (*Viburnum rafinesquianum*) are the two most dominant understory or ground cover species, with average cover values of 6.3 and 7.8%, respectively.

Trees in Stand OS-12 have the second largest average dbh measurements, at 33.58 cm. Tree size is larger in Stand OS-12 than in OS-03, where the average dbh is only 22.23 cm.

Mesic

Five mesic stands in the site vicinity were sampled quantitatively: OS-01, OS-02, OS-04, OS-06 and OS-09.

All five have Sugar Maple as one of the two most dominant tree species. Three, OS-01, OS-02 and OS-04, have American Beech as the co-dominant. The remaining two are co-dominated by Red Oak.

Table 3 provides additional details regarding the vegetation composition of these five stands. Structurally, the five mesic stands appear to be quite similar. Stand OS-01 contains the smallest and likely the least mature individual trees relative to the other four. Stands OS-06 and OS-09 support the largest trees overall. Stand OS-04 contains several large individual White Oak trees, each with an average dbh in excess of 50 cm (Table 3).

Stand OS-02 has a relatively sparse ground cover stratum, with Spotted Jewelweed providing the largest average percent cover (0.6 %). Several other species are represented, including Large-leaved Aster, Common Speedwell (*Veronica officinalis*). Pasture Gooseberry (*Ribes cynosbati*) and Wild Sarsaparilla (*Aralia nudicaulis*). Table E-1 (Appendix E) gives the average percent cover values of the ground flora species encountered in all 15 of the site and site vicinity stands quantitatively sampled.

Wet-mesic

Stands OS-10 and OS-13 are categorized as wet-mesic. Stand OS-10 is situated to the northwest of the site at the edge of the site vicinity (Figure 6). It occupies a low area adjacent to a large shallow swale in the Silverdale Woods. Stand OS-13 occupies a low area bordering Sucker Creek, to the north of the site (Figure 6).

Stand OS-10 is dominated by Red Maple, with an importance value of 97. Trembling Aspen and Swamp White Oak are lesser dominants, with importance values of 35 and 31, respectively. Southern Arrow-wood, Large-leaved Aster and Wild Sarsaparilla are important components of the ground cover stratum.

Stand OS-13 is dominated by White Ash and Red Maple. White Oak is also relatively important. Importance values for the three are 88, 80 and 43, respectively. Buttonbush comprises a large component of the ground cover, with an average cover value of 9%.

Stand OS-13 is composed of fewer and relatively larger individual trees, with an average dbh of 40.26 cm. By comparison, average dbh in Stand OS-10 was calculated at 25.98 cm.

3.2.3.2 Thicket

One thicket area in the site vicinity, Stand OS-15, was selected for detailed study. This thicket is located adjacent to the west-central edge of the site (Figure 6) and is dominated by Buttonbush. Other similar thickets are scattered throughout the site vicinity. Another major thicket area in the site vicinity is dominated by a low shrub canopy of Narrow-leaved Meadowsweet.

Other plant species commonly encountered in thicket areas are Climbing Nightshade, Star Duckweed (*Lemna trisulca*), Beggar-ticks (*Bidens frondosa*) and Winterberry (*Ilex verticillata*).

3.2.3.3 Marsh

Marsh is the dominant vegetation type in the low swales which occur in the site vicinity. These swales are present in the distinct linear pattern described in Section 3.2.1.

Dominant wetland plants encountered in this habitat type include: Narrow-leaved Cattail, Rice Cut Grass (*Leersia oryzoides*), Beggar-ticks and Swamp Milkweed (*Asclepias incarnata*).

3.2.3.4 Field

Almost all of the field in the site vicinity appears to be recently disturbed. In very few instances were blocks of old field observed.

Old field

One small parcel of old field (Stand OS-14) situated adjacent to the west side of the site (Figure 6) was studied in detail. Four native goldenrod species dominate the ground cover stratum in this field: *Solidago canadensis*, *S. altissima*, *S. nemoralis* and *Euthamia graminifolia*.

Recently disturbed field

Large tracts of this vegetation type occur in the site vicinity, in a mosaic with agricultural lands (Figure 6). The one area studied in detail (Stand OS-16) is dominated by aggressive, introduced plant species, including Bird's-foot Trefoil, Cow Vetch (*Vicia cracca*) and Quack Grass (*Agropyron repens*).

3.2.4 FACILITY SERVICING CORRIDORS

Heaslip Road Corridor: Process Water Main/Surface Water Discharge Pipeline

The purpose of facility servicing corridors are described in Section 1.4 of this report and their locations are noted on Figure 4.

The margins of Heaslip Road, which runs from Vaughan Road south to the Welland River (Figure 6), are characterized by a mosaic of agricultural lands (crop and pasture), wooded pockets and hedgerows.

The corridor is lined in places with mature Sugar Maple, Norway Spruce (*Picea abies*) and White Ash. Scattered individuals of Bur Oak, Red Oak, American Elm and Shagbark Hickory are also present.

Along most roadside edges, the ditches are dominated by a mix of weeds characteristic of dry conditions. Examples include Common Milkweed (*Asclepias syriaca*), Timothy and Redtop (*Agrostis gigantea*).

In one location approximately 1.1 km south of the site, 9C Creek passes close to the road (Figure 6). A variety of wetland species dominate the roadside margin at this point, including: Reed Canary Grass (*Phalaris arundinacea*), Soft Rush (*Juncus effusus*) and Rice Cut Grass.

Water Intake Pumphouse Station

The proposed pumphouse station location on the bank of the Welland River is dominated by a hawthorn (*Crataegus* sp.) thicket with scattered American Elm and Bur Oak in the overstory. No aquatic vegetation was observed during field investigations; however, cattail, bur-reed and coontail were reported from the Welland River at the southern end of Heaslip Road (OMNR 1985c). The shoreline thicket community is bordered by old field.

Ground cover species growing under the hawthorn canopy and in adajent open field areas include: Canada Goldenrod, Wild Carrot (*Daucus carota*) and Bird's-foot Trefoil.

Regional Road 24/Highway 20 Natural Gas Pipeline Corridor

The margins of Regional Road 24 from the Town of Vineland south to Highway 20 and the margins of Highway 20 west to Schram Road are occupied by a variety of different land uses: residences, agricultural fields, woodlots and hedgerows. Only trees situated within the road right-of-way were noted, since these are most likely to be affected by the construction of a natural gas pipeline. Most of these trees are scattered hawthorns, maples or oaks.

Silverdale Road Corridor

The margins of Silverdale Road from the Ontario Hydro 115 kV transmission line south to the 4th Concession, are comprised predominantly of agricultural fields. No trees grow within the road right-of-way along this section of Silverdale Road.

3.2.5 REPRESENTATIVENESS OF VEGETATION

Representativeness addresses the similarity of vegetation conditions in the site and site vicinity study areas to those in a larger geographic area. It is an important concept because it identifies the structure and composition of significant vegetation communities (i.e., those containing rare species). This analysis of the factors affecting rarity provides input to the determination of the significance of potential impacts.

The site and site vicinity study area vegetation was compared with the results of other botanical studies conducted elsewhere in the Regional Municipality of Niagara and in adjacent areas to the east and west of Niagara. While most of these local studies examined only the flora of the area (as indicated by a list of the plant species present), some provided more detail with respect to the general vegetation structure and composition. Major works reviewed for this analysis included the following: Macoun (1893), Zenkert (1934), Hamilton (1943), Landon (1960), Maycock (1963, 1987), Cruise (1969), Yaki (1970), Zenkert (1975), Zander (1976), Zander and Pierce (1979), Macdonald (1980), Mitchell and Sheviak (1981), Clemants (1986), and Gartshore et al. (1987a, 1987b). All sources consulted are listed in Section 11.0.

Field investigations conducted by GLL in other parts of the Regional Municipality of Niagara during Phases 3B and 4A of the OWMC Site Selection Process also contributed to an understanding of representativeness.

The results of the literature review and field investigations indicate that the vegetation encountered in the preferred site and in the site vicinity is representative of conditions which prevail on similar physiographic situations elsewhere in the Regional Municipality of Niagara, and also throughout much of the Deciduous Forest Region.

Of particular use in this determination were results of quantitative investigations completed for 131 woodland stands throughout the Deciduous Forest Region of southern Ontario, 15 of which are located on the Haldimand Clay Plain. These published data (Maycock 1963), as well as information contained in background working files (Maycock 1987), were compared with the results of quantitative studies completed on and adjacent to the preferred site in Phase 4B (see Table D-1, Appendix D).

Both Maycock's work and the studies carried out in Phase 4B used comparable sampling techniques (i.e., Point-centred Quarter Analysis). Differences did exist between the number of forest stands examined (sample size), the geographic distribution of the stands and woodlot size. Maycock's studies focused on representative woods greater than 4 ha (10 acres) in size and which exhibited no signs of recent disturbance. Phase 4B studies included several stands smaller than 4 ha, some with evidence of recent logging activity. Despite these differences, some comparisons can be drawn.

A comparison of importance values for tree species for each of the three data sets is presented in Table D-1 (Appendix D). The importance value is a numerical indication of the significance exerted on a stand by a particular species. The higher the value, the more important a particular species is in a stand (see Appendix M).

In the 131 stands, the three tree species with the highest importance values are, in descending order, Sugar Maple, American Elm and American Beech.

In the smaller subset of these data (the 15 Haldimand Clay Plain stands), five tree species had relatively high importance values. These are, in descending order of importance, American Elm, American Beech, White Ash, Sugar Maple and Red Maple.

On the preferred site and in the site vicinity, the five tree species which attained the highest importance values, (i.e., Sugar Maple, Red Maple, White Ash, Red Oak and American Beech in descending order of importance) were similar to those identified by Maycock. Red Oak and Red Maple are present at higher importance values on the preferred site and in the site vicinity than in stands studied by Maycock (1963, 1987).

This comparison suggests that the majority of dominant species on and adjacent to the preferred site are indeed similar to and thus typical of much of the Deciduous Forest Region. Greater variability exists between the importance values of minor tree species recorded by Maycock (1963, 1987) and those noted for the same species during Phase 4B investigations.

In addition to comparing importance values, a comparison can be made of dominant tree species grouped according to soil moisture characteristics. Maycock (1963) discusses tree dominants based upon the following five soil moisture classifications: dry, dry-mesic, mesic, wet-mesic, and wet. Phase 4B studies encountered stands representative of three of these classifications, dry-mesic, mesic and wet-mesic (Table E-1). In dry-mesic woods sampled during the 4B study the four tree species with the highest importance values are Red Oak, White Oak, American Beech, and Sugar Maple, in descending order of importance. All but Sugar Maple are identified by Maycock (1963) as characteristic of dry-mesic situation throughout the Deciduous Forest Region. Maycock (1963) assigns Sugar Maple to a mesic classification. In the Phase 4B study, however, the importance value for Sugar Maple was higher in mesic stands than in dry-mesic stands.

Similarities in representative trees are also present in the mesic and wet-mesic situations. The above comparisons, in conjunction with field experience and a review of literature, confirm the overall representativeness of the forest vegetation on the site and in the site vicinity. This implies that there is no special significance attached to the vegetation communities present on and around the site and that they are not unlike those found elsewhere in the region.

3.2.6 RARE PLANT SPECIES

A review of Phase 4A and 4B data indicates that of the 441 species encountered in the preferred site and the site vicinity (Appendix C), eight are considered to be rare.

Rarity is a term which varies widely in definition and application. It, along with representativeness, was selected for a detailed assessment because both play an important role in natural systems. Rare species and their habitats are the focus of this sub-section of the report.

Rarity infers a lack of abundance or a scattered, restricted occurrence of a species within a given geographic area (e.g. nationally, provincially, regionally,). It is important to recognize both the rare species and the habitats which support them in order to fully evaluate potential impacts on these resources. The displacement, for example, of the last station of a plant species in a county, region or larger geographic area would be undesirable. (A "station" is defined as one or more individuals of a plant species growing in close proximity to one another and generally refers to a collecting location; see Appendix M).

The literature sources used to determine rarity are discussed in Appendix F. Within this appendix, Table F-1 provides a summary of the criteria used by each source to define rarity.

In order to evaluate the rarity of the eight species on a comparative basis relative to one another within the context of the Phase 4B study, a level of significance was assigned to each. Three relative levels of significance (high, medium, low) were defined, each distinguished on the basis of a number of considerations, including: published status, geographic and demographic factors and other considerations. The means by which determination of rarity and evaluation of significance were achieved are detailed in Appendix F.

The following description of rare species is organized by study area (site and site vicinity) and by significance level. The occurrence of the rare species is described and the reasons for its significance level are briefly discussed. More detailed information is contained in Appendix F.

3.2.6.1 Site

Six rare species have been recorded on the preferred site. These are listed below:

Common Name	Scientific Name	Significance Level
Pin Oak	Quercus palustris	high
Wood's Sedge	Carex woodii	medium
Black Gum	Nyssa sylvatica	medium
Small Bedstraw	Galium trifidum	medium
Southern Arrow-wood	Viburnum recognitum	medium
Blunt-leaved Sandwort	Arenaria lateriflora	medium

Most of the rare plant species confirmed on the site during Phase 4B field investigations are concentrated in the northwest quadrat of the site (Figure 8, back pocket), coinciding with the distribution of the bulk of on-site forest.

High Significance Species

Pin Oak has been designated as an occurrence of high significance on the preferred site. Six stems occur along the wet margins of Stands 4 and 7 (Figure 8). Two of the six stems are sapling size, while the remainder represent more mature trees.

Pin Oak occurs in the Niagara Peninsula, isolated from populations further south in New York and Pennsylvania (Fowells 1965; see Figure F-2-1 in Appendix F). The occurrence of this species on the site appears to represent one of the westernmost stations for this species in the Niagara Peninsula. Since the completion of the botanical fieldwork conducted by GLL in 1986, additional records of Pin Oak have been obtained from two wetland complexes, both situated approximately 15 km west-northwest of the preferred site (OMNR 1987b). These two wetlands are referred to as Caistor Centre Southwest (Moore's Creek Tributary) and Caistor Centre Southwest (Mill Creek Tributary) (OMNR 1987c, 1987d). No details regarding the number of individuals or the health and regenerative status of these Pin Oaks are available (OMNR 1987f). The distribution of this species in Ontario as mapped by Argus (in press; see Figure F-2-2 in Appendix F) does not show the locations of these more westerly stations.

Medium Significance Species

The occurrence of several stems of Wood's Sedge in Stand 2 (Figure 8), represents only the second known station in the Regional Municipality of Niagara (Pryer, pers. comm., 1986; Ball, pers. comm., 1986). The only other documented station is in the Short Hills Wilderness Area (Hamilton Naturalists Club 1982). Although Wood's Sedge is considered regionally rare (Zander and Pierce 1979), it is apparently widespread or common elsewhere in southern Ontario (Argus and White 1982). The presence of Wood's Sedge on the preferred site is considered an occurrence of medium significance.

On the eastern edge of Stand 6, on the margins of a seasonally wet swale (Stand 6a), two coppice clumps of Black Gum occur.

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Figure 8 depicts the wide distribution of Southern Arrow-wood on the site. Only the main concentrations of this wetland shrub are mapped. The largest populations encountered were found in Stands 4 and 7.

While both Black Gum and Southern Arrow-wood are designated as provincially and nationally rare (Argus, in press; Argus and Keddy 1984), the plants in question do not represent range extensions or disjuncts to the main southern populations. Published sources and field experience indicate that both species occur at numerous stations within and to the west of the Niagara Peninsula. Black Gum is referred to as regionally "common" and Southern Arrow-wood as regionally "common and widespread" in the Regional Municipality of Haldimand-Norfolk (Sutherland 1987).

Several stems of Small Bedstraw were observed growing on a small, moss-covered hummock at the north end of Stand 6a (Figure 8). Small Bedstraw, although not documented as provincially or nationally rare, is considered regionally rare (Zander and Pierce 1979) and appears to have a limited regional distribution. It is assigned the status of "uncommon" in the adjacent Regional Municipality of Haldimand-Norfolk (Sutherland 1987).

The occurrence of Blunt-leaved Sandwort on the site was not confirmed during Phase 4B field studies. Its presence was reported by Webber (1984a, 1984b) and cited in GLAL (1985a). Suitable habitat for this species, i.e., moist situations, meadows and the borders of woods (Zenkert 1934; Fernald 1970), exists on the site.

The designation of Blunt-leaved Sandwort as regionally rare and endangered (Zander and Pierce 1979) is based primarily on the earlier work of Zenkert (1934). More recent studies conducted in adjacent areas report the species to be "uncommon" in the Regional Municipality of Haldimand-Norfolk (although of widespread distribution in woods on the Haldimand Clay Plain) (Sutherland 1987) and common in New York State (Mitchell, pers. comm., 1986).

3.2.6.2 Site vicinity

Four rare plant species were recorded in the site vicinity study area. Most occur within 500 m of the site and their locations are depicted on Figures 8 and 9 (back pocket). The four species are listed below:

Common Name	Scientific Name	Significance Level
Black Gum	*Nyssa sylvatica*	medium
Southern Arrow-wood	*Viburnum recognitum*	medium
Intermediate Leather Grape Fern	*Botrychium multifidum*	medium
Canada Plum	*Prunus nigra*	low

Medium Significance Species

Both Black Gum and Southern Arrow-wood also occur on-site and are discussed in Section 3.2.6.1.

A large number of stems of Black Gum occur along the wet edge of Stand OS-04, adjacent to a Buttonbush thicket (Stand OS-15). There are approximately 31 saplings and 75 seedlings present (Figure 9).

Southern Arrow-wood was found thinly scattered in wet habitat throughout the site vicinity. The largest populations of this wetland shrub occur along the edges of Stands OS-04 and OS-10 (Figure 9).

Intermediate Leather Grape Fern stems were observed in Stand OS-10, a wet-mesic deciduous woodlot (Silverdale Woods) situated in the northwest corner of the site vicinity (Figure 9).

This fern is designated as rare in the Niagara Frontier Region (Zander and Pierce 1979). It is considered common in neighbouring New York State (Mitchell, pers. comm., 1986) but "very uncommon" in Regional Municipality of Haldimand-Norfolk (Sutherland 1987), where its occurrence appears to be restricted to the Norfolk Sand Plain.

Low Significance Species

One individual Canada Plum was identified along the edge of Stand OS-04, among the concentration of Black Gum saplings and seedlings (Figure 9).

Although designated as rare in the Niagara Frontier Region (Zander and Pierce 1979), Soper and Heimburger (1982) refer to it as common throughout southern Ontario. It is also considered common in neighbouring New York State (Mitchell, pers. comm., 1986) and "probably common" on the Haldimand Clay Plain portion of the Regional Municipality of Haldimand-Norfolk (Sutherland 1987).

3.3 WILDLIFE

3.3.1 SITE

Wildlife communities on the preferred site are described according to the following life forms: birds, mammals, reptiles and amphibians, and butterflies. Species richness, dominance and habitat utilization are discussed. Definitions of these terms are provided in a glossary (Appendix M).

3.3.1.1 Birds

The results of the Phase 4B study revealed the presence of 75 species of birds on the preferred site (Appendix G). Most of these were recorded during GLL field work, although several additional species were recorded during Ontario Breeding Bird Atlas field work conducted on the site in June, 1985 (Curry 1986).

Fifty-three of the bird species recorded on the site are summer visitors or residents and are presumed to breed. The remaining 22 non-breeding species involve winter visitors or migrants observed by GLL staff during winter and late spring field visits. Bird species richness on the preferred site is typical of rural situations in southern Ontario.

Two breeding bird census plots were established on the site, one woodland and one field. The woodland plot is 6.6 ha in size and the field plot is 5.3 ha in size. The locations of these census plots are shown on Figure 5.

A total of 32 species of birds was recorded in the larger of the two woodlots (breeding bird plot SW) which occupy the northwest corner of the site. Of these, 22 species are considered to be breeding residents; the remainder are classified as "visitors" (Table 4). Twenty-nine breeding pairs were enumerated, dominated by Eastern Wood-Pewee (Contopus virens) and Gray Catbird (Dumetella carolinensis).

These two species occupied dense thickets surrounding two large sloughs in this woodlot. Many of the birds recorded on plot SW are typical "edge" species which occur around the perimeter of the woodlot: American Robin (Turdus migratorius), Indigo Bunting (Passerina cyanea), Song Sparrow (Melospiza melodia), and American Goldfinch (Carduelis tristis). Relatively few individuals occupied territories in the interior of this woodlot.

Collectively, the breeding bird community in this habitat is comprised of species commonly found throughout southern Ontario. Most are characteristic inhabitants of small, second growth woodlots.

A total of 25 species of birds was recorded in a 5.5 ha weedy field (plot SF on Figure 5) adjacent to the larger of the two woodlots on site (Table 5). The margins of this plot are dominated by dense wet willow-oak thickets, accounting for the high proportion of "edge" species encountered. Low-lying pockets of cattail marsh bordering drainage swales are also scattered throughout this plot.

The dominant species on this breeding bird plot are, in descending order of abundance, Red-winged Blackbird (Agelaius phoeniceus), Song Sparrow, Yellow Warbler (Dendroica petechia), and American Robin (Table 5). Of these, only the Song Sparrow is a typical field species. Total number and density of breeding

TABLE 4: BREEDING BIRDS RECORDED ON THREE DECIDUOUS WOODLAND PLOTS, SITE AND SITE VICINITY*

PLOT SPECIES	SITE WOODLOT (SW) 6.6 ha		ADJACENT WOODLOT (AW) 5.9 ha		VICINITY WOODLOT (VW)- 12.5 ha	
Great Blue Heron					+	
Mallard	+					
Red-tailed Hawk	0.5	(7.5)	0.5	(8.5)	+	
American Kestrel	+					
Killdeer	+		+			
Common Snipe	+					
American Woodcock	+					
Mourning Dove	1	(15)			1	(8)
Ruby-throated Hummingbird			+		+	
Downy Woodpecker	1	(15)	1	(17)	2	(16)
Hairy Woodpecker					1	(8)
Northern Flicker	1	(15)	1	(17)	1	(8)
Pileated Woodpecker					+	
Eastern Wood-Pewee	3	(45)	2	(34)	5	(40)
Least Flycatcher					3	(24)
Great Crested Flycatcher	+		+		1	(8)
Eastern Kingbird	0.5	(7.5)	1	(17)	0.5	(4)
Blue Jay	1	(15)	1	(17)	3	(24)
American Crow	1	(15)	2	(34)	1	(8)
Black-capped Chickadee	1	(15)	2	(34)	3	(24)
White-breasted Nuthatch	+		+		1	(8)
Veery	+		+		1	(8)
Wood Thrush	+		+		2	(16)
American Robin	2	(30)	2	(34)	5	(40)
Gray Catbird	3	(45)	+		4	(32)
Brown Thrasher	1	(15)			+	
Cedar Waxwing			1	(17)		
Yellow-throated Vireo					1	(8)
Warbling Vireo					1	(8)
Red-eyed Vireo			1	(17)	4	(32)
Yellow Warbler	1	(15)	1	(17)	3	(24)
Cerulean Warbler	+					
Ovenbird					4	(32)
Common Yellowthroat	1	(15)	0.5	(8.5)	1	(8)
Scarlet Tanager					1	(8)
Northern Cardinal	0.5	(7.5)			2	(16)
Rose-breasted Grosbeak	1	(15)	+		2	(16)
Indigo Bunting	2	(30	2	(34)		
Song Sparrow	2	(30)	3	(51)	5	(40)
Red-winged Blackbird	0.5	(7.5)	1	(17)		
Common Grackle	2	(30)	1	(17)	3	(24)
Brown-headed Cowbird	+				+	
Northern Oriole	1	(15)	+		2	(16)
American Goldfinch	2	(30)	2	(34)	3	(24)
Total Species (Species Richness)	32		28		35	
Total No. of Breeding Pairs	29	(435)	25	(425)	66.5	(532)
Density of Breeding Pairs/ha	4.4		4.2		5.3	

Note: For each plot, the left hand column is the number of territorial males actually found within the study plot. Immediately following this number, within parentheses, is the number of pairs that would theoretically be found on an identical plot 100 ha in size. The purpose of this is to provide a uniform standard of density for comparison with other species and other census plots. The symbol "+" is used to denote that a territorial male of the species in question was recorded on less than half the visits to the plot. A value of "0.5" indicates that a territorial male of the species in question was recorded on exactly half (i.e., 3) of the visits to the plot. For each plot the total number of species (species richness) is indicated. Total number and density of breeding pairs are also given. The value within parentheses represent total number of breeding pairs on a theoretical 100 ha plot.

TABLE 5: BREEDING BIRDS RECORDED ON TWO WEEDY FIELD PLOTS, SITE AND SITE VICINITY

PLOT / SPECIES	SITE FIELD (SF) 5.3 ha		VICINITY FIELD (VF) 5.6 ha	
Mallard			1	(18)
Red-tailed Hawk	+			
Killdeer			2	(36)
Spotted Sandpiper			1	(18)
American Woodcock			1	(18)
Ring-billed Gull	+			
Rock Dove	+		0.5	(9)
Mourning Dove			+	
Black-billed Cuckoo	+			
Willow Flycatcher	2	(38)	1	(18)
Least Flycatcher	2	(38)		
Eastern Kingbird	1	(19)	1	(18)
Barn Swallow	0.5	(9.5)	2	(36)
American Robin	4	(76)	1	(18)
Gray Catbird	3	(57)	+	
Brown Thrasher	0.5	(9.5)		
Cedar Waxwing	+			
Yellow Warbler	5	(95)	1	(18)
Common Yellowthroat	6	(114)	2	(36)
Indigo Bunting	1	(19)		
Field Sparrow	+			
Savannah Sparrow	2	(38)	3	(54)
Song Sparrow	6	(114)	3	(54)
Bobolink	3	(57)	1	(18)
Red-winged Blackbird	6	(114)	6	(108)
Eastern Meadowlark	+		0.5	(9)
Common Grackle	3	(57)	1	(18)
Brown-headed Cowbird	+			
Northern Oriole	+		+	
American Goldfinch	3	(57)	2	(36)
House Sparrow			+	
Total Species (Species Richness)	25		23	
Total No. of Breeding Pairs	48	(912)	30	(540)
Density of Breeding Pairs/ha	9.1		5.4	

Note: For each plot, the left hand column is the number of territorial males actually found within the study plot. Immediately following this number, within parentheses, is the number of pairs that would theoretically be found on an identical plot 100 ha in size. The purpose of this is to provide a uniform standard of density for comparison with other species and other census plots. The symbol "+" is used to denote that a territorial male of the species in question was recorded on less than half the visits to the plot. A value of "0.5" indicates that a territorial male of the species in question was recorded on exactly half (i.e., 3) of the visits to the plot. For each plot the total number of species (species richness) is indicated. Total number and density of breeding pairs are also given. The value within parentheses represent total number of breeding pairs on a theoretical 100 ha plot.

pairs/100 ha calculated for this plot are considerably higher than the same values for a vicinity field plot (plot VF) of comparable size (Table 5; see also Section 3.3.2.1). These differences are largely attributable to the greater amount of thicket and "edge" habitat present on plot SF, which serves to attract a greater number and density of breeding pairs.

All the species recorded on plot SF are very common elements of the southern Ontario avifauna. None is rare or otherwise significant.

3.3.1.2 Mammals

A group of six White-tailed Deer was observed by GLL staff on the preferred site on January 24, 1986. Fresh deer tracks were also found during the winter, marking a trail which runs through the larger woodlot on-site in an east-west direction. Evidence suggests that very few animals utilize this route at any one time. Recent aerial deer census data (OMNR 1982, 1985a, 1986a) reveal that winter deer use of the site is not significant. While the woodlots on the preferred site apparently act as "stepping stones", linking other small wooded "islands" to the east and west, the majority of deer inhabiting the area surrounding the preferred site reside in the larger wooded complexes to the north and east (e.g., Silverdale Woods and Comfort's Bush; see Section 3.3.2.2).

Small mammal trapping was carried out on the preferred site from August 6-8 and September 3-5, 1986. Details concerning the methods employed in sampling small mammal populations are provided in Section 2.4.2 and Appendix B.

TABLE 6 : NUMBER OF TRAPS, TRAP NIGHTS, AND CATCH PER 100 TRAP NIGHT FOR FIVE MAMMAL TRAPPING TRANSECTS, SITE AND SITE VICINITY (AUGUST - SEPTEMBER, 1986)

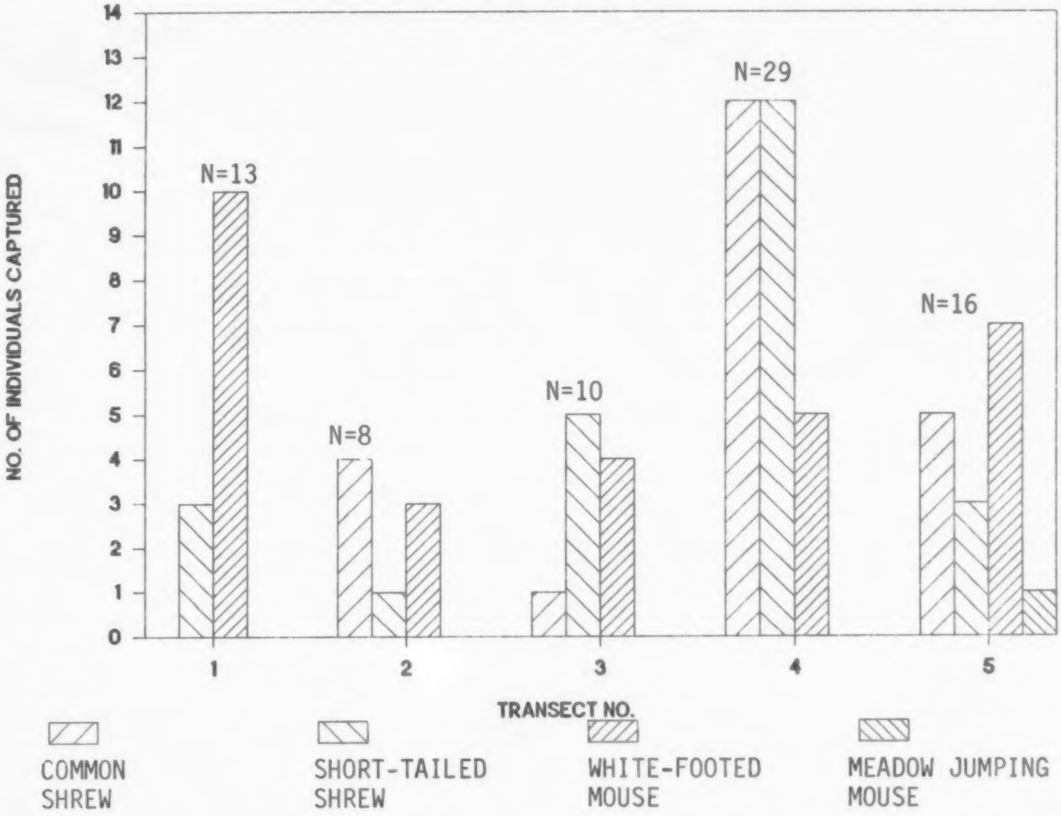
TRANSECT #	NUMBER OF TRAPS DEPLOYED SNAP	NUMBER OF TRAPS DEPLOYED PITFALL	TOTAL # OF TRAPS	TOTAL # TRAP NIGHTS	CATCH / 100 TN
1	26	4	30	180	7.22
2	12	13	25	150	5.33
3	12	13	25	150	6.66
4	20	10	30	180	16.1
5	30	0	30	180	8.88
TOTAL	100	40	140	840	

NOTE : Transects # 1, 2, and 3 were situated on the site; Transects # 4 and 5 were situated in the site vicinity (see Figures 5 and 6 for locations)

TABLE 7 : NUMBER OF CAPTURES, CATCH PER 100 TRAP NIGHTS (TN) AND PERCENT OF TOTAL CATCH REPRESENTED BY EACH SMALL MAMMAL SPECIES, SITE AND SITE VICINITY (AUGUST - SEPTEMBER, 1986)

SPECIES	NUMBER OF CAPTURES	PERCENTAGE OF TOTAL CAPTURES	CATCH / 100 TRAP NIGHTS
White-footed Mouse (Peromyscus leucopus)	29	38.2%	3.5
Short-tailed Shrew (Blarina brevicauda)	24	31.6%	2.9
Common Shrew (Sorex cinereus)	22	28.9%	2.6
Meadow Jumping Mouse (Zapus hudsonicus)	1	1.3%	0.1
Total	76	100.0%	9.1

FIGURE 10: RELATIVE ABUNDANCE OF FOUR SPECIES OF SMALL MAMMALS, SITE AND SITE VICINITY (AUGUST - SEPTEMBER, 1986)



Three transects (#1, #2 and #3) containing a total of 80 traps were established in the larger of the two woodlots on site. Transect locations are indicated in Figure 5. Numbers of traps deployed, total number of trap nights, and catch per 100 trap nights for each of these three transects are summarized in Table 6. Number of captures, catch per 100 trap nights and percent of total catch represented by each species are summarized in Table 7.

A total of 31 individuals representing three species of small mammals was captured on the preferred site in 1986 (Figure 10). Collectively, White-footed Mouse (Peromyscus leucopus) was the most abundant species encountered on these three transects, followed in descending order of abundance by Short-tailed Shrew (Blarina brevicauda) and Common Shrew (Sorex cinereus). White-footed Mice predominated on Transect #1, located on a dry upland ridge, while the majority of the shrews were captured on Transects #2 and #3, near the edges of wet, low-lying sloughs. All three species captured on the preferred site during this study are common elements of small mammal communities in southern Ontario.

Eleven additional species of mammals were recorded on the preferred site during Phase 4B (Appendix H), either through direct observations or through evidence such as tracks and scats. All but one, Virginia Opossum (Didelphis virginiana), are common residents of weedy field, wet shrub thicket and second-growth woodland habitats in southern Ontario.

On July 3, 1986, a dead opossum was discovered in a small hay barn at the junction of Heaslip Road and Vaughan Road (Figure 8). The skeleton was collected and donated to the Royal

Ontario Museum, Toronto. Although the Virginia Opossum is considered to be a "provincially significant" mammal species (Ontario Ministry of Natural Resources and Canadian Wildlife Service 1984), it is apparently common and of widespread distribution throughout the Niagara Peninsula (Duncan 1985) and the Regional Municipality of Haldimand-Norfolk to the west (Gartshore 1987). The provincial and regional status of the Virginia Opossum is discussed in greater detail in Section 3.3.3.

3.3.1.3 Reptiles and amphibians

A total of 11 species of reptiles and amphibians is reported to occur on the preferred site. These are listed in Appendix I.

Field investigations conducted in late spring of 1986 revealed the presence of large numbers of Striped Chorus Frogs (Pseudacris triseriata), Spring Peepers (Hyla crucifer), Green Frogs (Rana clamitans), Leopard Frogs (R. pipiens), and American Toads (Bufo americanus). These species were found breeding in ponds, sloughs and intermittent drainage channels (including 9C Creek) throughout the site.

Despite the availability of suitable breeding habitat, no salamanders of the genus Ambystoma were found in these woodland sloughs. Redback Salamanders (Plethodon cinereus) were found in low numbers on the site.

Only two snake species were recorded on the site, Garter Snake (Thamnophis sirtalis) and Redbelly Snake (Storeria occipitomaculata).

The herpetofaunal population on the preferred site is comprised of few species, all of which are common residents of southern Ontario. No rare or significant taxa were recorded. Although unconfirmed reports of the occurrence of the nationally, provincially, and regionally rare Black Rat Snake (Elaphe obsoleta) on the site were received during Phase 4A (GLAL 1985a), this species was not found during Phase 4B field investigations (see Section 3.5).

3.3.1.4 Butterflies

A total of 16 species of butterflies was recorded on the preferred site during Phase 4B. These are listed in Appendix J. All are common and of widespread distribution in southern Ontario, particularly in weedy field and forest "edge" habitats.

3.3.2 SITE VICINITY

3.3.2.1 Birds

A total of 94 species of birds was recorded in the site vicinity study zone during Phase 4B (Appendix G). While most of these species were recorded during GLL field work, additional species were recorded as a result of 1985 field work conducted for the Ontario Breeding Bird Atlas Project (Foley, pers. comm., 1986) and 1986 field observations made by Knapton (pers. comm., 1986).

Sixty-eight of the bird species recorded in the site vicinity are summer visitors or residents and are presumed to breed. The remaining 26 non-breeding species involve winter visitors or migrants observed during winter and late spring field visits conducted by GLL staff and Knapton (pers. comm., 1986). None of these non-breeding species is considered rare or otherwise significant.

Three breeding bird census plots were established in the site vicinity, two woodland and one field (Figure 6). A 5.9 ha woodlot (plot AW) near the intersection of Highway 20 and Schram Road was censused. This woodlot lies immediately adjacent to the northeast corner of the preferred site and falls within a 500 m radius of the site. It was chosen because it is of comparable size to plot SW, situated on the site.

A total of 28 species of birds was recorded in this plot. The species richness, composition, and total number and density of breeding pairs recorded in this plot are very similar to those values attained in plot SW (Table 5). Twenty-four species were common to both plots. Dominant species were also similar; e.g., Song Sparrow, Eastern Wood-Pewee, American Robin, and Indigo Bunting. The majority of males encountered occupied territories on the perimeter of the woodlot or around the margins of wet sloughs. Few birds utilize the interior of this woodlot for breeding. None of the taxa found on this plot is rare or significant.

A second breeding bird census plot 12.5 ha in size (plot VW) was established in the site vicinity, in woodland habitat on the north side of the 4th Concession in the Silverdale Woods complex (Figure 6).

A total of 66.5 breeding pairs representing 35 species was recorded on this census plot (Table 5). Species richness and total number and density of breeding pairs were higher than those recorded on the other two woodland plots investigated (Table 4). This is due, in part, to the relatively larger area surveyed.

The overstory stratum on plot AW is more mature and less disturbed than those of the other two. This, coupled with the fact that the plot is contained within a larger, contiguous wooded complex rather than a small, isolated wooded "island", has a positive influence on species richness and density.

Many of the species found breeding on plot VW are absent from plots SW and AW. These are primarily birds which typically occupy larger territories in woodland interiors; e.g., Ovenbird (*Seiurus aurocapillus*), Scarlet Tanager (*Piranga olivacea*), Yellow-throated Vireo (*Vireo flavifrons*), Wood Thrush (*Hylocichla mustelina*), and Veery (*Catharus fuscescens*). The latter two species were recorded on both SW and AW, but only as visitors. Edge species are well represented along the southern and western margins of the plot, defined by an unpaved road and a cultivated field, respectively.

None of the species recorded on this breeding bird census plot is rare. According to Knapton (pers. comm., 1986), Niagara Regional Co-ordinator of the Ontario Breeding Bird Atlas Project, Yellow-throated Vireos are "locally uncommon" in the Regional Municipality of Niagara. A male Yellow-throated Vireo was heard singing on several occasions from the same location in plot VW, suggesting territorial defense.

In Niagara, the Ovenbird is at the southern limit of its breeding range in the province and nesting records are almost exclusively confined to large wooded areas (Knapton, pers. comm., 1986). Although the Ovenbird is considered "regionally uncommon" in Niagara (Knapton, pers. comm., 1986), its status is largely due to the absence of suitable breeding habitat. Where suitable habitat does exist (e.g., Silverdale Woods), the relative density of breeding pairs is often quite high (see Table 4).

As breeding bird habitat, plot VW supports more species at higher densities than either SW or AW. The age and size of this stand and its relatively undisturbed condition provide more niches for breeding birds to occupy, particularly canopy nesters, ground nesters and cavity nesters. This plot also supports species requiring larger territories.

A 5.6 ha breeding bird census plot (plot VF) was established in fallow field habitat west of Silverdale Road (Figure 6). This plot is quite comparable in size to plot SF, situated on the site, but contains a smaller proportion of thicket vegetation along its margins. A total of 23 species was recorded on this plot. Species richness values for plots SF and VF are very similar. Total number and density of breeding pairs calculated for plot VF are both considerably lower, however (Table 5). As mentioned in Section 3.3.1.1, this difference is largely attributable to the influence of "edge" habitat on the breeding bird composition of plot SF.

Plot VF is generally drier than SF, accounting for the presence of Killdeer (Charadrius vociferus) and Spotted Sandpiper (Actitis macularia), two ground nesting species absent from SF. Other typical field species are found on both plots. None of the breeding birds occupying this plot is rare or otherwise significant.

3.3.2.2 Mammals

As previously discussed in Section 3.3.1.2, White-tailed Deer are more plentiful in the site vicinity than on the preferred site.

Recent aerial deer survey data indicate that in winter, most deer in West Lincoln Township are confined to large wooded areas such as Silverdale Woods and Comfort's Bush (OMNR 1982, 1985a, 1986a). In 1982, a total of 134 deer was recorded in West Lincoln Township, of which 47 (35.1%) were found in Comfort's Bush, situated 5 km due east of Site LF-9C (OMNR 1982). Winter surveys conducted in 1985 and 1986 (OMNR 1985a, 1986a) revealed that on average, 18.2% of all deer observed in the Township inhabited Silverdale Woods, a portion of which occupies the northwest corner of the site vicinity.

These data suggest that large wooded areas in West Lincoln Township provide ample food and shelter for deer populations during the winter. A mean estimate of 14.69 deer/km^2 for woodlots larger than 100 ha has been calculated for Niagara District (OMNR 1986b). The entire Silverdale Woods complex is 182.1 ha in size. This density estimate compares very favourably with the figure of 34 deer/square mile (13.18 deer/km^2) cited by Banfield (1974) as indicative of a dense population.

The results of our study suggest that no regionally significant deer wintering areas occur in the site vicinity. While the majority of deer in the site vicinity occur in Silverdale Woods and Sucker Creek Woods, to the north of Highway 20 (OMNR 1985a, 1986a), evidence suggests that some deer also utilize east/west movement corridors comprised of wooded "islands" interspersed with open field habitat. These corridors exist south of Highway 20 and north of Vaughan Road (see Section 3.3.1.2) and south of Vaughan Road and north of Elcho Road (Schuender, pers. comm., 1984).

Small mammal trapping was carried out in the site vicinity study area from August 6-8 and September 3-5, 1986. Details concerning the methods employed in sampling small mammal populations are provided in Section 2.4.2 and Appendix B.

Two transects (#4 and #5) containing a total of 60 traps were established in a portion of Silverdale Woods north of the 4th Concession. Transect locations are indicated in Figure 6 and are contained within the boundaries of breeding bird census plot VW. Number of captures, catch per 100 trap nights and percent of total catch represented by each species are summarized in Table 7.

A total of 45 individuals representing four species of small mammals was captured in the site vicinity study area during 1986. Collectively, Common Shrew was the most abundant species encountered on these two transects, followed in descending order of abundance by Short-tailed Shrew, White-footed Mouse and Meadow Jumping Mouse (Zapus hudsonicus). The relative abundance values obtained for the two site vicinity transects can be compared to those obtained for the three site transects in Figure 10.

Not surprisingly, the two shrew species predominated on Transect #4, which ran parallel to the edge of a large slough. This transect was situated in typical shrew habitat (wet areas) and contained 20 pitfall traps (Table 6) which were specifically intended to sample for small insectivores. Transect #5, by comparison, was situated on a dry upland ridge and comprised entirely of snap traps (Table 6). Eight shrews and eight mice (including the only Meadow Jumping Mouse captured during the entire small mammal study) were captured on this transect (Figure 10).

Twelve additional species of mammals were recorded in the site vicinity study area during Phase 4B (Appendix H), either through direct observations or through evidence such as tracks, burrows or scats. All but one are common inhabitants of weedy field, wet shrub thicket and native woodland habitats in southern Ontario. A desiccated Virginia Opossum carcass discovered beside Heaslip Road just north of the junction of Elcho Road (Figure 9) was photographed on April 2, 1986.

The provincial and regional status of this species is discussed in greater detail in Section 3.3.3.

3.3.2.3 Reptiles and amphibians

A total of 16 species of reptiles and amphibians is known to occur in the site vicinity study area. These are listed in Appendix I.

The composition of the herpetofauna of the site vicinity study area is quite similar to that of the site, but in terms of species richness is slightly higher. Six species not found on the site were found in the site vicinity: Eastern Newt (*Notophthalmus viridescens*), Bullfrog (*Rana catesbeiana*), Snapping Turtle (*Chelydra serpentina*), Painted Turtle (*Chrysemys picta*), Water Snake (*Nerodia sipedon*), and Milk Snake (*Lampropeltis triangulum*).

All of the frog and toad species encountered on the site were also encountered breeding in wet areas throughout the site vicinity. Large numbers of young-of-the-year Wood Frogs (*Rana sylvatica*) were also found in the Silverdale Woods area.

No rare or significant reptiles and amphibians were recorded during Phase 4B. Although unconfirmed site vicinity reports of the occurrence of the nationally, provincially and regionally rare Black Rat Snake were received during Phase 4A (GLAL 1985a), this species was not found during Phase 4B investigations (see Section 3.5.5). Snakes matching the description of a Black Rat Snake were reported to occur in a lumber mill yard on the west side of Highway 20, 1.0 km north of Bismarck (Yaromich, pers. comm., 1986). A search of this area was conducted by a GLL biologist on August 6, 1986 but did not reveal the presence of any Black Rat Snakes.

3.3.2.4 Butterflies

A total of 23 species of butterflies was recorded in the site vicinity study area during Phase 4B. These are listed in Appendix J. None is considered rare or significant on a regional, provincial or national basis.

While the majority of these species are expected to breed in the site vicinity, observations of Tiger Swallowtails (*Pterourus glaucus*) are believed to involve migrants.

3.3.3 RARE WILDLIFE SPECIES

Two rare wildlife species were recorded during the Phase 4B biology study.

One rare bird species was recorded on the preferred site in breeding bird census plot SW (Figure 8). A singing male Cerulean Warbler (*Dendroica cerulea*) was heard on May 22, 1986 but was not encountered on five subsequent censuses. In all probability this bird was a migrant individual, and there is no evidence to suggest that it nested on the site. The Cerulean Warbler typically nests in the canopies of mature deciduous woodland. The second growth nature of the woods on the preferred site makes it suboptimal breeding habitat for this species. In Ontario, the breeding distribution of the Cerulean Warbler is largely restricted to the Carolinian Zone, throughout which it is found in relatively small numbers (Speirs 1985). As a breeder, this species is considered to be provincially rare by Eagles and McCauley (1982). However, given that this species was not found to nest on the site, its occurrence is considered to be of low significance.

As previously mentioned in Sections 3.3.1.2 and 3.3.2.2, two dead Virginia Opossums were found during Phase 4B, one on-site near a barn at the junction of Heaslip Road and Vaughan Road (Figure 8), the other beside Heaslip Road in the site vicinity (Figure 9).

Since the distribution of this marsupial in Ontario was, until recently, thought to be restricted to the north shore of Lake Erie, the Niagara Peninsula and the Thousand Islands region (van Zyll de Jong 1983), the species is considered rare in Ontario (OMNR 1986e) and "provincially significant" (Ontario Ministry of Natural Resources and Canadian Wildlife Service 1984). Duncan (1985), however, reveals that the Virginia Opossum occurs commonly throughout the Niagara Peninsula and presents ample evidence to support his theory that the species not only is rapidly increasing in numbers but is also extending its range in both a northward and westward direction. Much of this range extension is believed to have occurred since 1980 (Duncan 1985). The Virginia Opossum is considered "common and increasing" in the Regional Municipality of Haldimand-Norfolk, situated to the west of the Regional Municipality of Niagara (Gartshore 1987).

Given that the Virginia Opossum is found commonly throughout the Niagara Peninsula (Duncan 1985), the presence of this species on and in the vicinity of the preferred site is considered to be of low significance.

3.4 FISHERIES

3.4.1 9C CREEK

3.4.1.1 Aquatic Habitat

An aquatic habitat survey of 9C Creek from its confluence with the Welland River upstream to the southern boundary of the preferred site was undertaken on April 2, 1986 (Figure 6).

Three habitat types occur along 9C Creek. These are:

- marsh and swale (upstream of Vaughan Road);
- ditch (between Vaughan Road and Elcho Road); and
- pasture (from Elcho Road downstream to the Welland River).

Brief descriptions of each habitat type are provided below.

Marsh and Swale

On the preferred site, 9C Creek is formed from shallow ditches and depressions. Surface water ponds at the southern boundary of the site adjacent to Vaughan Road form a shallow marsh approximately 0.5 ha in area. Sections of the creek bottom are covered with terrestrial grasses, indicating that the stream is seasonally intermittent.

Ditch

9C Creek has been ditched from south of Vaughan Road to Elcho Road. The creek forks approximately 200 m downstream of Vaughan

Road; the western branch flows overland, while the eastern fork flows through an underground culvert. Exposed sections of the creek flow through cultivated fields. They are devoid of overhead or instream cover and are consequently susceptible to instream heating and siltation.

Pasture

The portion of 9C Creek downstream of Elcho Road to Regional Road 63 flows through active livestock pasture land. In this section the creek follows a more natural flow path than that observed upstream of Elcho Road, but a lack of bank formation and the presence of grassed substrates along much of the stream course indicates that this section of the creek is also seasonally intermittent. Overhanging cover is absent. Access to the creek by livestock is uninhibited and observations indicate that livestock are watered along the creek.

In April, 1986 the width of the creek bed south of Elcho Road averaged less than 1.0 m and its depth less than 0.3 m. At the mouth of 9C Creek, stream flow volume was estimated at less than 2 m^3/s. However, observations made in mid-March 1986 indicate that during periods of intense snow melt and spring runoff the lower portion of 9C Creek floods and water is ponded to a depth of approximately 2.0 m at Regional Road 63. In the spring of 1986, flood waters inundated a section of low lying pasture land approximately 2 ha in area which extended approximately 300 m upstream from Regional Road 63. Flood waters were present in 9C Creek for a period of approximately two weeks before returning to the above described conditions.

Water temperatures measured in 9C Creek at Vaughan Road in mid-to late March ranged from 4-9° C.

9C Creek discharges to the Welland River through a small cement culvert located under Regional Road 63. The culvert is positioned so that its outlet was elevated 40 cm above water levels occurring in the Welland River during the spring fisheries survey conducted on April 3, 1986. A combination of high water levels in both the Welland River and in 9C Creek must be coincident before the barrier created by the culvert can be breached by migrating fish. In 1986 this combination occurred for a short period of time in mid-to late March and also in late May, following several days of intense rainfall.

Other barriers to upstream migration of fish in 9C Creek are located at Elcho Road and at Vaughan Road. Metal culverts 60 cm in diameter and approximately 10 m in length are located at each road crossing. The downstream outlet of each culvert is elevated above the stream bed by approximately 30 cm, preventing upstream movement of fish in all conditions except peak spring runoff or following major storm events.

3.4.1.2 Fish community composition

No fish were observed in 9C Creek during the spring field surveys. On May 22, 1986, a Common Carp (*Cyprinus carpio*) was observed in 9C Creek on the upstream side of Regional Road 63 in a small pool. This pool was created by storm water runoff and was dry the following week.

Nine young-of-the-year carp were captured in minnow traps at the junction of 9C Creek and Elcho Road (Fish Sampling Station #4, Figure 6) on August 11, 1986. The evidence of young fish suggests that the creek is used by carp for spawning purposes. No fish were captured at the junction of 9C Creek and Vaughan Road (Fish Sampling Station #3, Figure 6).

Two additional fish species, Central Mudminnow (Umbra limi) and Brook Stickleback (Culaea inconstans), were recorded in 9C Creek (Table 8).

3.4.2 BEAVER CREEK

3.4.2.1 Aquatic habitat

Beaver Creek is a tributary of the Welland River. Its confluence with the Welland River is located approximately 3.0 km downstream of the Village of Wellandport and 0.5 km upstream of the mouth of 9C Creek (Figure 4).

Beaver Creek is a permanently flowing creek. Although flow conditions in Beaver Creek have not been monitored, a flow volume of 1.3 m /s was estimated during the spring fisheries survey conducted on April 3, 1986.

Flooding in the lower reaches of Beaver Creek creates favourable spawning habitat for spring spawning species such as Bowfin (Amia calva) and Northern Pike. During high water associated with periods of spring runoff, the lower sections of Beaver Creek flood adjacent areas of old field and brushy thicket. Observations made in March, 1986 suggest that flood levels are maintained in these areas for a period of at least two to three weeks.

Access to all but the lower section of Beaver Creek by migrating fish is restricted by a farm access road which runs south from Regional Road 63 and spans Beaver Creek on Lot 18, Concession 1 (Figure 11). A submerged culvert under this road provides the only upstream access route. The culvert is presently in a state of disrepair and access through the culvert is partially blocked by broken stone. Observations made on April 3, 1986 indicate, however, that Northern Pike breach this

TABLE 8 : NUMBER OF FISH CAUGHT IN MINNOW TRAPS IN 9C CREEK AND BEAVER CREEK ON AUGUST 11,1986

SPECIES	STN #3	STN #4	STN #5	STN #6	TOTAL
Central Mudminnow (Umbra limi)	0	1	0	3	4
Common Carp (Cyprinus carpio)	0	9	0	0	9
Brook Stickleback (Culaea inconstans)	0	8	0	1	9
Total No. of Individuals	0	18	0	4	22
Total No. of Species	0	3	0	2	3

STN #3 : 9C Creek at Vaughan Road
STN #4 : 9C Creek at Elcho Road
STN #5 : Beaver Creek at Vaughan Road
STN #6 : Beaver Creek at Elcho Road

partial barrier during periods of high water and move into the upstream portions of Beaver Creek to spawn.

3.4.2.2 Fish community composition

Fish sampling using gill nets was carried out at the mouth of Beaver Creek (Fish Sampling Station #2, Figure 6) on April 3, 1986. This spring survey revealed that the lower section of Beaver Creek is inhabited by several species of fish, the most abundant of which are Brown Bullhead (Ictalurus nebulosus), White Crappie (Pomoxis annularis), Northern Pike and Bowfin. Spring gill netting data provided in Table 9 indicate that with the exception of White Crappie, these species were more common at the mouth of Beaver Creek than in the Welland River downstream of the mouth of 9C Creek (Table 10). This suggests that Beaver Creek is locally significant, either as a migratory route and/or as a spawning area.

In terms of its significance as a fisheries resource on a District level, however, Beaver Creek is classified as an "unproductive inland" watercourse (OMNR 1986d).

Three Central Mudminnows and one Brook Stickleback were captured in minnow traps at the junction of Beaver Creek and Elcho Road (Fish Sampling Station #6, Figure 6) on August 11, 1986. No fish were captured at the junction of Beaver Creek and Vaughan Road (Fish Sampling Station #5, Figure 6).

The assessment of the surface water resources of 9C and Sucker Creeks carried out during Phase 4B by M. M. Dillon Limited (1987a) does not identify any water quality conditions which would have a major negative impact on coarse fish populations. Although Beaver Creek was not sampled as part of

TABLE 9 : NUMBERS OF FISH CAUGHT IN WELLAND RIVER AT MOUTH OF BEAVER CREEK (STN #2)
(APRIL - SEPTEMBER, 1986)

		SAMPLING DATES									
		3/4/86		3/6/86		11/8/86		27/9/86		TOTALS	
COMMON NAME	SCIENTIFIC NAME	# OF FISH	CUE	# OF FISH	CUE	# OF FISH	CUE	# OF FISH	CUE	# OF FISH	CUE
Bowfin	Amia calva	12	(12)	0	(0)	2	(2)	2	(2)	16	(16)
Gizzard Shad	Dorosoma cepedianum	0	(0)	0	(0)	3	(3)	0	(0)	3	(3)
Northern Pike	Esox lucius	15	(15)	2	(3)	4	(4)	0	(0)	21	(22)
White Sucker	Catostomus commersoni	0	(0)	0	(0)	1	(1)	0	(0)	1	(1)
Shorthead Redhorse	Moxostoma macrolepidotum	0	(0)	5	(6)	0	(0)	1	(1)	6	(7)
Common Carp	Cyprinus carpio	1	(1)	1	(1)	1	(1)	0	(0)	3	(3)
Golden Shiner	Notemigonus crysoleucas	1	(1)	0	(0)	0	(0)	0	(0)	1	(1)
Brown Bullhead	Ictalurus nebulosus	35	(35)	9	(11)	9	(9)	0	(0)	53	(55)
Channel Catfish	Ictalurus punctatus	2	(2)	9	(11)	12	(12)	2	(2)	25	(27)
White Perch	Morone americana	0	(0)	0	(0)	3	(3)	4	(5)	7	(8)
Pumpkinseed	Lepomis gibbosus	8	(8)	0	(0)	0	(0)	0	(0)	8	(8)
White Crappie	Pomoxis annularis	21	(21)	10	(13)	10	(10)	4	(5)	45	(49)
Yellow Perch	Perca flavescens	0	(0)	2	(3)	0	(0)	0	(0)	2	(3)
Freshwater Drum	Aplodinotus grunniens	0	(0)	7	(9)	50	(50)	7	(9)	64	(68)
Total No. of Individuals		95	(95)	45	(57)	95	(95)	20	(24)	255	(271)
Total No. of Species		7		8		10		6		14	

NOTE : CUE = Catch per unit effort. The columns labelled "# of Fish" represents the actual number of fish captured during the sampling event. The columns labelled "CUE" represent an extrapolation of the number of fish which would be expected to be captured during a 24-hour set (i.e., 24-hours elapse between the time the net is set and the time the net is pulled). In cases where both columns are identical, a 24-hour set was used. Where the values in each column differ, CUE has been adjusted to reflect a 24-hour set.

TABLE 10 : NUMBERS OF FISH CAUGHT IN WELLAND RIVER AT MOUTH OF 9C CREEK (STN #1)
(APRIL - SEPTEMBER, 1986)

		SAMPLING DATES									
		3/4/86		3/6/86		11/8/86		27/9/86		TOTALS	
COMMON NAME	SCIENTIFIC NAME	# OF FISH	CUE	# OF FISH	CUE	# OF FISH	CUE	# OF FISH	CUE	# OF FISH	CUE
Bowfin	Amia calva	1	(1)	0	(0)	0	(0)	1	(1)	2	(2)
Gizzard Shad	Dorosoma cepedianum	0	(0)	0	(0)	4	(4)	0	(0)	4	(4)
Northern Pike	Esox lucius	3	(2)	0	(0)	2	(2)	1	(1)	6	(5)
White Sucker	Catostomus commersoni	4	(2)	2	(3)	0	(0)	2	(2)	8	(7)
Shorthead Redhorse	Moxostoma macrolepidotum	1	(1)	2	(3)	1	(1)	2	(2)	6	(7)
Common Carp	Cyprinus carpio	0	(0)	3	(4)	3	(3)	1	(1)	7	(8)
Golden Shiner	Notemigonus crysoleucas	9	(5)	10	(13)	1	(1)	1	(1)	21	(20)
Brown Bullhead	Ictalurus nebulosus	66	(33)	4	(5)	3	(3)	9	(11)	82	(52)
Channel Catfish	Ictalurus punctatus	23	(11)	5	(6)	0	(0)	6	(7)	34	(24)
White Perch	Morone americana	0	(0)	0	(0)	0	(0)	1	(1)	1	(1)
Rock Bass	Ambloplites rupestris	1	(1)	0	(0)	0	(0)	0	(0)	1	(1)
Pumpkinseed	Lepomis gibbosus	8	(4)	2	(3)	0	(0)	0	(0)	10	(7)
White Crappie	Pomoxis annularis	44	(22)	23	(28)	4	(4)	16	(19)	87	(73)
Yellow Perch	Perca flavescens	2	(1)	1	(1)	0	(0)	1	(1)	4	(3)
Freshwater Drum	Aplodinotus grunniens	21	(11)	16	(20)	15	(15)	3	(4)	55	(50)
Total No. of Individuals		183	(94)	68	(86)	33	(33)	44	(51)	328	(264)
Total No. of Species		12		10		8		12		15	

NOTE : CUE = Catch per unit effort. The columns labelled "# of Fish" represents the actual number of fish captured during the sampling event. The columns labelled "CUE" represent an extrapolation of the number of fish which would be expected to be captured during a 24-hour set (i.e., 24-hours elapse between the time the net is set and the time the net is pulled). In cases where both columns are identical, a 24-hour set was used. Where the values in each column differ, CUE has been adjusted to reflect a 24-hour set.

the Dillon study, spring conditions in 9C Creek and Sucker Creek are expected to be similar to those which prevail in Beaver Creek.

3.4.3 WELLAND RIVER

3.4.3.1 Aquatic habitat

The Welland River is the largest water body in the area and abuts the southern edge of the site vicinity study area (Figure 4). All surface water runoff from the site eventually drains to the Welland River. In the site vicinity the Welland River has a very low gradient meandering slowly through agricultural farm land and deciduous forest habitat. Its shoreline is bordered by alternating steep banks and low flat floodplains.

The Welland River between Beaver Creek and 9C Creek has a fairly uniform width of approximately 20 m, with a mean depth of about 2.0 m. The deepest portions of the river reach a maximum depth of approximately 4.0 m.

Water levels in the Welland River are controlled primarily by water levels in Ontario Hydro's Chippawa Power Canal facility (situated approximately 35 km downstream of the study area) and depending on the season, water may flow downstream, upstream or not flow at all.

Instream substrate of the Welland River is clay. Consequently, the river is very turbid. Secchi disc transparency measured during the spring survey (April 3, 1986) was less than 0.4 m. Aquatic macrophytes are limited to the shallow margins of the river, and are virtually absent at depths greater than 1.0 m. Stream bank instability has caused a number of large

Black Willows (Salix nigra) to fall into the river, creating some cover for fish.

An evaluation of the quality and quantity of available fish habitat along the Welland River in the study area indicates that this section of the river is not unique nor does it provide critical fish habitat.

However, the entire stretch of the Welland River from the City of Welland to the Village of Wellandport (which contains the study area) has been identified as a Class 1 wetland on the basis of a recent evaluation (OMNR 1985c, Figure 11).

A provincial evaluation system (Ontario Ministry of Natural Resources and Canadian Wildlife Service 1984) is used to evaluate the significance of wetlands and to rank them into one of seven possible classes. Classification is based on a point scoring system. Wetlands which attain sufficient points to qualify as Class 1 or Class 2 wetlands are considered to be of "provincial significance" and "should be protected from incompatible activities wherever possible" (OMNR 1984a).

Movement of fish along the portion of the Welland River within the study area is unimpeded by structural barriers. At present, the river is open to fish migration from its confluence with the Niagara River upstream as far as the Welland Ship Canal (situated approximately 22 km downstream of the mouth of 9C Creek).

The Welland River passes below the Welland Ship Canal by means of three large inverted siphons situated at a depth of

10 m below the surface of the land. It is estimated that a minimum of 200 m³/day of water enters the Welland River from the Welland Ship Canal via these inverted siphons. These siphons are believed to act as a partial barrier to the movement of fish within the Welland River (Dickman and Steele 1986).

Further evidence that two geographically isolated fish populations (one upstream of the Welland Ship Canal and the other downstream) inhabit the Welland River is provided by Dickman and Steele (1986). Their study of the frequency of gonadal neoplasms in Common Carp X Goldfish (Carassius auratus) hybrids revealed that the incidence of neoplasms was significantly higher in the industrialized portion of the Welland River (downstream of the Welland Ship Canal). Hybrids upstream of the canal did not reveal any neoplasms, suggesting that these fish represent a separate population, physically prevented from mixing with the downstream population.

3.4.3.2 Fish community composition

A list of the fish species collected during Phase 4B from the Welland River at the mouth of 9C Creek is provided in Table 10. These data indicate that the Welland River fish community is composed of at least 15 warm water species, the majority of which are typical inhabitants of many rivers entering the lower Great Lakes. Several of the species collected, e.g., White Perch (Morone americana) and Freshwater Drum (Aplodinotus grunniens), are typically found in the Great Lakes and in the lower reaches of large rivers entering the Great Lakes. Their presence in the Welland River upstream of the Welland Ship Canal may indicate that these populations have been isolated from the Niagara River and Lake Erie since the construction of the canal.

The fish species in this section of the Welland River most often associated with sports fishing are Yellow Perch (Perca flavescens) and Northern Pike. These species were found in relatively low numbers in comparison to other fish collected (Table 10). The five most common fish species collected in the Welland River during Phase 4B were White Crappie, Brown Bullhead, Freshwater Drum, Channel Catfish (Ictalurus punctatus), and Golden Shiner (Notemigonus chrysoleucas).

Sampling carried out during mid-summer (June 3 and August 11, 1986) obtained the fewest individual fish, compared to the numbers obtained during spring and fall sampling. These low catch rates in summer may be due to the quiescence of the fish inhabiting the Welland River during a period of stress. No major changes in species composition took place over the course of the study and species richness, which ranged from 8 to 12 species, also remained fairly constant throughout (Table 10).

The results of Phase 4B fish sampling carried out in the Welland River provide a useful comparison with the results of a similar gill netting study conducted between November 1977 and November 1978 (Steele 1981). The location of the 1977-78 survey was situated approximately 1 km downstream of the mouth of 9C Creek.

Steele (1981) captured a total of 20 species of fish (and an additional two hybrids) from this downstream location. Of these, 14 were also captured by GLL during the Phase 4B fish study, indicating a strong similarity in species composition. The following six species reported by Steele (1981) were not found during the Phase 4B fish study: Smallmouth Bass

(Micropterus salmoides), Goldfish, River Redhorse (Moxostoma carinatum), Black Bullhead (Ictalurus melas), Yellow Bullhead (I. natalis), and Stonecat (Noturus flavus). Five of these six species were captured in October and November (no Phase 4B sampling was carried out during these months), suggesting that Steele's (1981) data reflect seasonality in fish species composition.

The four most abundant species recorded by Steele (1981), White Crappie, Brown Bullhead, Channel Catfish and Freshwater Drum, are the same as the four most abundant species recorded in Phase 4B. A comparison of the data obtained in each study reveals very strong similarities among species composition, species richness, relative abundance and seasonal populations.

3.4.4 RARE FISH SPECIES

None of the 17 fish species recorded in the Welland River, Beaver Creek and 9C Creek during Phase 4B (Appendix K) is considered rare.

There is some uncertainty concerning Steele's (1981) report of River Redhorse from this portion of the Welland River. Although the fish collected by Steele were deposited in the collection of the Royal Ontario Museum, there are no voucher specimens of River Redhorse from the Welland River (Crossman, pers. comm., 1987).

In Ontario, this nationally "rare" (Committee on the Status of Endangered Wildlife in Canada 1984; McAllister et al. 1985) and provincially "threatened" (Beak Consultants Limited 1980) species is only known from three small, widely separated populations inhabiting the Mississippi, Grand, and Ausable River systems (Beak Consultants Limited 1980). Since the River Redhorse is extremely difficult to distinguish from other members of the genus Moxostoma, it is often misidentified (Beak Consultants Limited 1980). Based on these factors, we conclude that Steele's (1981) report may not be valid, a conclusion supported by Crossman (pers. comm. 1987). More likely, this occurrence pertains to the Shorthead Redhorse (M. macrolepidotum), a common species which was not reported by Steele (1981) Twelve individuals of Shorthead Redhorse were captured during the Phase 4B study (Tables 9 and 10).

3.5 OTHER BIOLOGICAL CONSIDERATIONS

3.5.1 SIGNIFICANT ENVIRONMENTAL UNITS (SEUs)

The term Significant Environmental Units (SEUs) collectively refers to Environmentally Sensitive/Significant Areas (ESAs), Areas of Natural and Scientific Interest (ANSIs) and Areas of Important Biological Resources (AIBRs). Definitions of these terms are provided in a glossary (Appendix M).

No SEUs occur on the preferred site. Portions of three SEUs occur within the site vicinity study area (Figure 11, back pocket). The eastern end of the Silverdale Woodlot (SEU 8-4), also known as the St. Ann's Slough Forest (Macdonald 1980), occupies the northwestern corner of the site vicinity. It is situated approximately 500 m from the preferred site at its closest point (Figure 11). The physiography of this 300 ha woodlot is representative of the linear slough ridge pattern found throughout the Haldimand Clay Plain. The upland ridge areas support a rich forest association dominated by oak, maple and beech. Several tributaries of Sixteen Mile Creek and the Welland River flow through or originate in this SEU.

The Silverdale Woodlot satisfies five of the ESA criteria established by Brady et al. (1980): the area represents a headwater, is large in areal extent, contains rare species, supports an unusually high diversity of biological communities, and exhibits high quality wildlife habitat.

This area is also recognized by the OMNR as an ANSI of "provincial significance" and as a candidate nature reserve (Macdonald 1980; Regional Municipality of Niagara 1985). A wetland evaluation of the area carried out in 1985 determined that the South St. Ann's Slough Forest is a Class 2 wetland (OMNR 1985b) and therefore of "provincial significance" (Figure 11).

Sucker Creek Woodlot (SEU 18-5) is a flat, poorly-drained woodlot, the southern end of which extends into the northeast corner of the site vicinity to within approximately 750 m of the preferred site (Figure 11). It fulfills four ESA criteria (Brady et al. 1980). Sucker Creek is a headwater area, supports rare species, and contains a biotic community which is indicative of both high diversity and high quality.

The east-central portion of the site vicinity is occupied by Davison's Bush (SEU 18-8), also referred to as the Northwest Boyle Forest (Macdonald 1980). This 65 ha area is comprised of an open marsh surrounded by an upland forest association of oak, maple and beech. It is situated approximately 1.25 km east of the preferred site (Figure 11). Davison's Bush has been designated as both an ESA (Brady et al. 1980) and an ANSI "of significance other than regional or provincial" (Macdonald 1980).

3.5.2 SILVERDALE WOODS HERONRY

Information concerning the presence of a nesting colony of Great Blue Herons in the Silverdale Woods was received during Phase 4A. The heronry was reported to be situated north of the unopened road allowance along the 4th Concession, just west of the northwest corner of the site vicinity (Curry, pers. comm., 1984; Figure 11).

A visit to the area on January 17, 1986 revealed the presence of a heronry in the location described. A total of 50 nests was counted at this time. The nests were situated high in mature beech and oak trees and appeared to be in good condition, suggesting fairly recent occupancy.

Six subsequent visits were made to this area by GLL biologists between late March and mid-July, 1986. No nesting herons were found and, after early May, none of the empty nests could be located presumably due to dense tree foliage.

We have concluded that this heronry is no longer active and may not have been occupied for the past two years. Lampman (pers. comm., 1986) recalls that in 1983 or 1984 this heronry contained approximately 75 active nests, with as many as five or six nests in one tree.

An aerial survey of the area on July 21, 1986 also failed to locate any active heron nests in this section of the Silverdale Woods or elsewhere in the site vicinity. However, an active colony of nesting Great Blue Herons was discovered 4 km due west of the previous site, just west of where Highway 20 intersects the Silverdale Woods (Figure 11).

A visit was made to this heronry on August 6, 1986. A total of 20 nests was counted. Although nesting had been completed and the herons had left the colony by the time the visit was made, it appeared that all the nests had recently been active, as evidenced by the amount of guano deposited on and below the nest trees. All the nests were situated in Red Oaks, generally at a height of approximately 15 to 18 m. Discussions with the owner of an adjacent property (Yaromich, pers. comm., 1986) revealed that herons also occupied this site in 1985 but were not definitely known to be present prior to this date. Since the Silverdale Woods heronry was apparently last occupied in 1984, it is possible that this new heronry is comprised of birds which previously nested in Silverdale Woods.

This heronry is one of only three heronries presently known to be active in Niagara District (OMNR 1986c). The other two are situated in Wainfleet Bog and near Attercliffe. Data concerning the length of occupancy and numbers of nesting pairs occupying these heronries are unavailable; the Attercliffe heronry, however, is known to be threatened by disturbance from local landowners (OMNR 1986c).

3.5.3 FISH SPAWNING AREAS

Phase 4B investigations indicate that fisheries habitat along the length of 9C Creek is severely constrained by a lack of water in the stream during the spring spawning and egg incubation periods and by barriers to upstream migration. Although there is evidence that carp spawning occurs in 9C Creek, it is unlikely that a significant number of fish of other species are produced in this watercourse.

Netting data collected during 1986 indicate that Beaver Creek is a locally significant watercourse, providing reproductive habitat for several species of fish, including Northern Pike (Figure 11).

The fish habitat in the Welland River immediately upstream and downstream of the mouth of 9C Creek offers some potential for spawning sport fish species. This section of the Welland River also acts as a migration route for several fish species entering Beaver Creek and other local tributaries to spawn (Figure 11).

Sucker Creek, which drains an area to the north and east of the preferred site (Figure 11), is also reported to support spawning Northern Pike in spring as far upstream as Highway 20 (McPherson, pers. comm., 1986). This pike run was previously considered to be of local significance based on evidence reviewed during Phase 4A (GLAL 1985a). However, since Sucker Creek was not included in the geographic scope of the Phase 4B biology study, no fish sampling data are available to substantiate the significance of this watercourse as a fish spawning area.

3.5.4 COMPARISON OF PHASE 4A AND PHASE 4B DATA

Biological information provided to GLL during Phase 4A contained several site and site vicinity reports of species which are considered rare either nationally, provincially, or regionally.

Six rare plant species were reported from the preferred site and site vicinity study areas during Phase 4A (GLAL 1985a). Of these, Blunt-leaved Sandwort and Big Shellbark Hickory (Carya laciniosa) were not observed during Phase 4B, while Spray Aster (Aster pilosus) has recently been removed from the Atlas of Rare Vascular Plants in Ontario (Argus and Keddy 1984) and lumped with a more common variety for taxonomic reasons (Semple, pers. comm., 1984). Four additional rare plant species were recorded for the first time during Phase 4B.

Although Blunt-leaved Sandwort was not observed on the site in Phase 4B, suitable habitat for this species does exist and therefore its occurrence is considered probable (see Section 3.2.6.1 and Appendix F).

Big Shellbark Hickory was reported from the preferred site in Phase 4A by Meyers (1984). Webber (1984a) suggested that an unusual hickory encountered in the same area as that described by Meyers was likely Pignut Hickory (Carya glabra). Detailed field work was undertaken during Phase 4B, in the area where these unusual hickories were reported to occur. Plant material was collected from many specimens for verification. All material subsequently examined was verified as the common Shagbark Hickory (C. ovata) (Ball, pers. comm., 1986).

The rare Black Gum was reported to occur on both the site (one location) and in the site vicinity (three locations) during Phase 4A (GLAL 1985a). The presence of Black Gum was not confirmed at these locations during Phase 4B work. However, one site and one site vicinity population were located and are plotted on Figures 8 and 9.

Although suitable habitat for Black Gum exists in three of the four areas where this species was reported to occur during Phase 4A, these areas have not been shown on Figure 8. The species' occurrence in these areas is potentially represented by very few scattered individual stems which were not found despite intensive Phase 4B investigations.

Reports of the occurrence of six rare wildlife species on the preferred site and in the site vicinity were cited in the Phase 4A biology report (GLAL 1985a). All six were included on the basis of information reported to GLL by others and none was confirmed by GLL as a result of field work conducted in Phase 4A.

Field work conducted in Phase 4B resulted in concrete evidence to support the occurrence of only one of these species, the Virginia Opossum (see Section 3.3.3).

Records of the other five wildlife species accorded a "rare" designation in Phase 4A, Eastern Bluebird (*Sialia sialis*), Orchard Oriole (*Icterus spurius*), Lynx (*Lynx lynx*), Bobcat (*L. rufus*), and Black Rat Snake, were not substantiated by the results of Phase 4B field work.

3.5.5 RESOURCE USE

3.5.5.1 Forestry

Some recent or current forestry activity was observed in a number of woodlots throughout the site and site vicinity. The nature of this activity ranged from a very light selective cut to clearcutting. The trees harvested were likely used for fuelwood, sawlog and veneer log production.

Areas where some forestry activity was observed during Phase 4B are highlighted on Figure 11. Although entire stands are highlighted, logging activity was generally restricted to smaller areas within individual stands.

A portion of Davison's Bush (Figure 11) is subject to a Woodlot Improvement Agreement (W.I.A. 75-81) which permits selective harvesting of trees until 1991 (OMNR 1984c). A conifer plantation on the northeast corner of the junction of Silverdale Road and the 4th Concession is also subject to a Woodlot Improvement Agreement (Figure 11).

3.5.5.2 Trapping

The preferred site falls within an area trapped by one licensed trapper. Roadside ditches and wet low-lying areas on the site and in the site vicinity are trapped. These areas are shown on Figure 11. The most recent (1982-83) statistics available show that 635 Muskrats (Ondatra zibethicus) and 70-80 Raccoons (Procyon lotor) were trapped in this area (McPherson, pers. comm., 1984). It is not known how many of these animals were captured on the site proper.

The presence of wet sloughs and creek beds throughout makes the site and site vicinity "excellent" areas in which to trap Muskrat (McPherson, pers. comm., 1986). McPherson (pers. comm., 1986) also carried out demonstrations of trapping techniques in the larger of the two woodlots on the preferred site as part of a course he teaches. In a regional context, however, the preferred site is not a significant trapping area, as the average annual yield on-site is comparable to that recorded in the surrounding area (McPherson, pers. comm., 1984).

3.5.5.3 Hunting

Although the preferred site and the site vicinity are collectively described as a "good deer hunting area" (OMNR 1984b), there are no statistics available to substantiate this claim. Spent shotgun cartridges were occasionally encountered throughout the site and vicinity during Phase 4B field work, suggesting that some waterfowl and upland gamebird hunting does occur. It is not known what species are involved, nor in what number they are harvested.

Waterfowl hunting along the Welland River represents only 0.3% of the total estimated annual kill in Niagara District (OMNR 1978). Although it is not known how many ducks are harvested from the small portion of the Welland River being studied in Phase 4B, this area is very likely an insignificant waterfowl hunting area.

3.6 FUTURE SCENARIOS

The purpose of this section of the report is to make predictions about future biological conditions in the study area. These future scenarios are of value in predicting conditions without the OWMC facility and in identifying issues relating to mitigative measures, monitoring and contingency which would be influenced by changes in biological conditions other than those created by construction and operation of the OWMC facility.

The future scenarios are presented in this section. The implications of these predictions for other issues are addressed subsequently.

Three different scenarios of future biological conditions have been developed. At one extreme, environmental degradation might occur. At the other extreme, major improvements in environmental quality might occur. The third scenario involves a combination of both extremes, with certain elements of the environment undergoing an improvement and other elements of the environment experiencing degradation.

The geographic scope of these predictions consider the preferred site and the lands immediately adjacent (site vicinity). The time frame involves potential changes which might occur between the present and the year 2000 or beyond.

There are several factors which might influence future environmental conditions in the study area. These include the following:

- dominant land use, e.g., intensity of agricultural activity, land value, costs of land improvement, cropping practices.
- other land use activities, e.g., construction of new facilities, residential, commercial, industrial developments.
- government programs regarding water quality, forest management, wetland management, fishery habitat improvement, subsidies for habitat maintenance and/or land drainage.
- programs of non-government organizations, such as agreements with landowners regarding protection and stewardship of natural habitat, e.g., Carolinian Canada Program, Ontario Heritage Foundation, Nature Conservancy of Canada.
- natural ecological succession of plant and animal communities.

The three scenarios described below are expressed as possible environmental conditions involving each factor.

Factors, factor conditions, and potential future situations for each of the three scenarios are described in Tables 11, 12 and 13.

Scenario 1 (degraded environment) would involve clearing of vegetation and associated wildlife habitat loss. The area of tile drained land would increase. Increased soil erosion and runoff would result in increased siltation and decreased water quality for aquatic life. The areal extent of natural habitat would be reduced, fewer wildlife species would use the site and fewer individuals and species of plants would inhabit the site.

In the site vicinity, woodlots would be cut and wetland areas would be drained. Tile drainage would increase on lands owned by farmers planting grain.

Scenario 2 (improved environment) would develop if agricultural land use gave way to natural succession of vegetation throughout the site. The number of individuals of rare plant species might increase, and a greater area of wildlife habitat and reptile, amphibian and fish habitat would exist. Trees would become mature and seedlings would develop to replace dead trees.

The quality of surface water draining the site would be relatively good. Riparian vegetation growth would aid in shading watercourses. Government and non-government programs which encourage the retention of woodlots and wetlands would increase the extent and enhance the quality of these habitat types.

Table 11 : Scenario 1 - Degraded Environment

Factor	Factor Conditions	Predicted Future Situation
LAND USE	Intensified Agriculture includes - more agricultural drainage - clearing all natural vegetation from site - more row crops planted	. decreased water quality, loss of wetland vegetation . loss of wildlife habitat, rare plant species . soil erosion, sedimentation
	or build poultry barn on preferred site - clear vegetation for barn - polluted runoff from manure	. loss of wildlife habitat, rare plant species . decreased water quality
GOVERNMENT PROGRAMS	Subsidy for land drainage	. more complete and rapid drainage, decreased water quality . loss of wetland vegetation
NON-GOVERNMENT PROGRAMS	None on site or in vicinity	. no improvement in habitat conservation
NATURAL SUCCESSION	Firewood cutting	. more mature trees cut

Table 12 : Scenario 2 - Improved Environment

Factor	Factor Conditions	Predicted Future Situation
LAND USE	Cease Agricultural Activity on site includes - no drainage works - natural vegetation succession - no tree cutting on site - low intensity agriculture on adjacent lands	. entire site provides wildlife habitat, more area for rare plant species . wetland, moist soil vegetation complex . uncultivated areas succeed through old field to forest, over time . mix of habitat types, some vegetated drainage swales, spring fish runs continue in some creeks
	or Small acreage of forage crops only on site (acreage equal to area currently cultivated)	. most of site provides wildlife habitat
	includes - no drainage works - natural vegetation succession - no tree cutting on site - low intensity agriculture on adjacent lands	. wetland, moist soil vegetation complex . uncultivated areas continue to develop into old field to forest, over time . forest matures . mix of habitat types, some vegetated drainage swales, spring fish runs continue in some creeks
GOVERNMENT PROGRAMS	Site and site vicinity - woodlot improvement - tree planting - wetland management - fisheries management	. more extensive tree cover . maintain habitat and rare species . programs to retain wetland, no additional agricultural drainage . improve habitat, fish populations in creeks and Welland River
NON-GOVERNMENT PROGRAMS	- potential involvement on site and in vicinity - conservation of natural habitat on private lands	. maintain habitat and rare species
NATURAL SUCCESSION	- no tree cutting, trees mature, natural seeding to replace dead trees - after cultivation ceases, succession to shrubs and trees	. continued tree cover, more rare plant species habitat . more extensive tree cover, more rare plant species habitat

Table 13 : Scenario 3 - Probable Future Environment

Factor	Factor Conditions	Predicted Future Situation
LAND USE	- Agriculture continues on site and in vicinity site - hay and grain grown on area currently cultivated - no additional drainage improvements - natural vegetation succession continues in uncultivated areas vicinity - acreage of crops remains similar to present day levels - no increases in tile row crop production - some increases in drainage	. continued existence of natural habitat on portions of the site . wetland vegetation, moist soil vegetation continues in swales . weedy, shrubby areas develop into trees
GOVERNMENT PROGRAMS	- no government involvement on site - woodlot management in off-site woodlots - no wetland or fisheries management in site vicinity	. future site conditions depend on land use activities . management of certain woodlots for wood production . extent and quality of wetland depends on land use . fisheries depends on water quality and habitat which are influenced by land use
NON-GOVERNMENT PROGRAMS	- no involvement on site - potential involvement in vicinity e.g. Silverdale Woods properties, conservation of natural habitat on private lands	. maintain habitat and rare species
NATURAL SUCCESSION	- succession continues with mature tree thinning caused by firewood cutting	. forest thinned to varying degrees, potential reduction in habitat for cavity nesting birds, structure of woodlot depends on intensity, frequency of tree cutting and species taken

The agricultural consultant (Ecologistics Limited 1987) has assumed that the overall character of the area as a rural agricultural community will remain intact and that the overall level of agricultural production in the area will not fall. If the agriculture assumptions prove correct, then the biology Scenario 2 will not develop.

Scenario 3 (probable future environment) is considered to be the most probable prediction of future biological conditions without the OWMC facility. Scenario 3 is based on past land use trends and changes in biological conditions, it is consistent with assumptions about future agricultural conditions, and it takes into account current and proposed government and non-government programs.

Data collected by Ecologistics Limited (1987), which are considered indicators of agricultural land use trends, show an increase in woodlot acreage between 1976 and 1981 in West Lincoln Township. The acreage of unimproved land also increased between 1976 and 1981. During the same period, woodlot acreage and acreage of unimproved land increased in the Regional Municipality of Niagara as a whole.

As noted earlier, Ecologistics Limited (1987) has assumed that the overall level of agricultural production in the area will not fall. Some increase in tile drainage is expected, but the intensity of row crop farming will depend on crop prices (Ecologistics Limited 1987).

Government initiatives which will affect wetland and woodlot habitat include the proposed property tax rebate on land identified as Class 1 or 2 wetland and policies regarding Areas of Natural and Scientific Interest (ANSIs). Both of these initiatives would be expected to encourage natural habitat retention in the site vicinity.

Natural vegetation will continue to flourish on the site and woodlots will continue to exist on adjacent properties. Firewood cutting in woodlots is expected to continue. This would thin out maturing trees and may reduce habitat for cavity nesting birds. Hay and some grain production would continue. Old field habitat would continue to mature, with shrub and young tree growth developing around the margin of the existing on-site woodlots.

If prices for cash crops improve, the area of tile drained land would increase. Wetland vegetation would continue to thrive in swales which are not cultivated for agriculture.

Under either Scenario 2 or 3 the extent and quality of available habitat would be as good as or better than that which exists at the present time.

4.0 FACILITY CHARACTERISTICS

The major components of the proposed OWMC waste treatment and disposal facility which relate to potential biological impacts are described in this section of the report. These include consideration of the following:

- physical-chemical treatment plant;
- incinerator;
- landfill;
- facility servicing options;
- surface water drainage;
- fencing and berming;
- construction activities;
- operational and maintenance activities; and
- post-operational activities.

For a detailed description of facility characteristics, the reader is referred to the report entitled Phase 4B Site Assessment Report - Facility Characteristics (Monenco Limited 1987a). An oblique perspective of the proposed facility layout is shown in Figure 12.

The initial capacity of the facility will be 150,000 t/a of waste, which is intended to expand to 300,000 t/a in year 10 of operations (Monenco Limited 1987b).

Additional details concerning such facility outputs as noise, air emissions, surface water drainage, and contaminant pathways are contained in the site assessment reports prepared by S.S. Wilson Limited (1987), Ontario Research Foundation (1987), M.M. Dillon Limited (1987a) and Environ Corporation (1987), respectively.

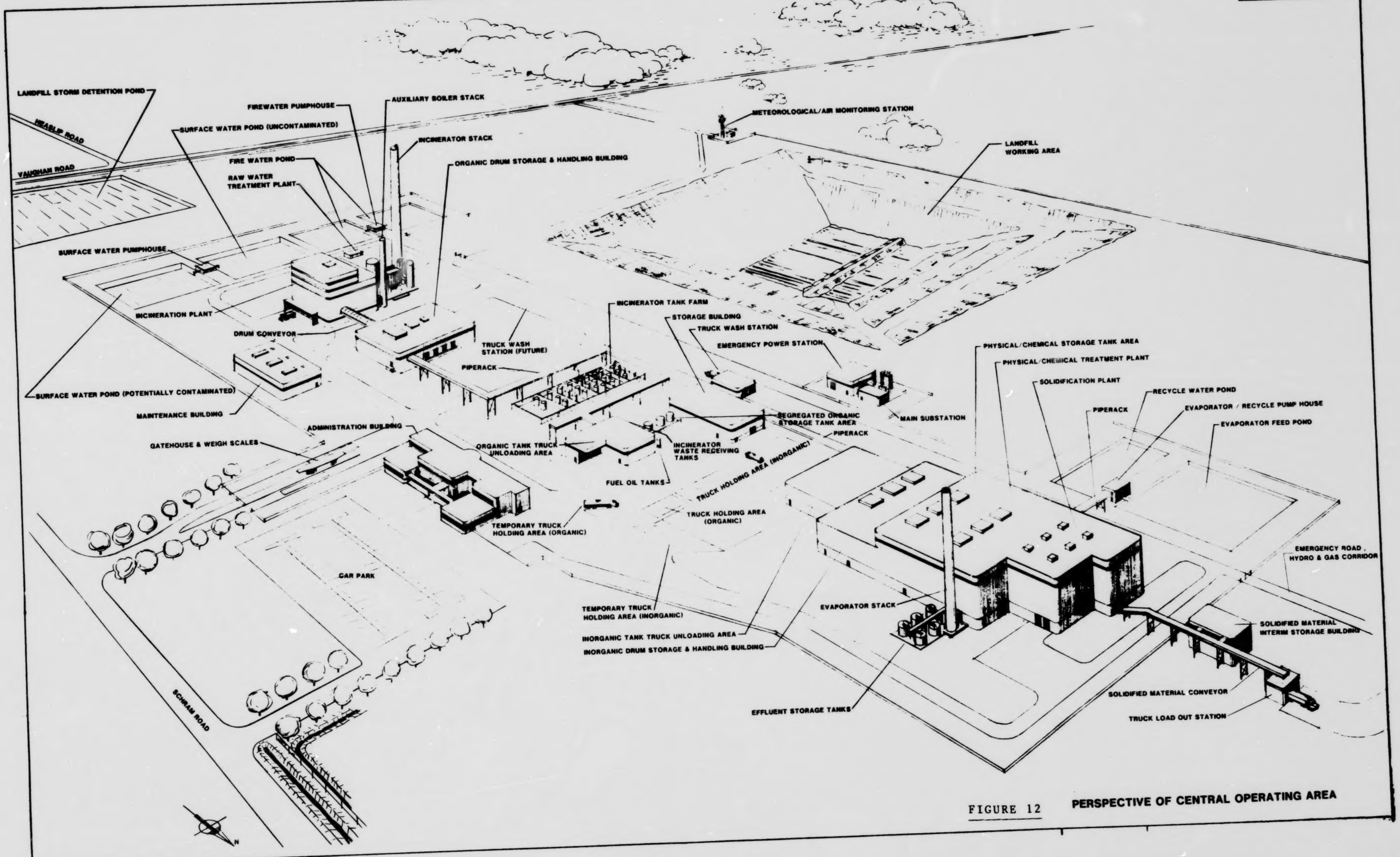

LANDFILL STORM DETENTION POND
HEASLIP ROAD
VAUGHAN ROAD
SURFACE WATER POND (UNCONTAMINATED)
FIREWATER PUMPHOUSE
AUXILIARY BOILER STACK
INCINERATOR STACK
FIRE WATER POND
RAW WATER TREATMENT PLANT
ORGANIC DRUM STORAGE & HANDLING BUILDING
METEOROLOGICAL/AIR MONITORING STATION
LANDFILL WORKING AREA
SURFACE WATER PUMPHOUSE
INCINERATION PLANT
DRUM CONVEYOR
TRUCK WASH STATION (FUTURE)
INCINERATOR TANK FARM
STORAGE BUILDING
TRUCK WASH STATION
EMERGENCY POWER STATION
PIPERACK
SURFACE WATER POND (POTENTIALLY CONTAMINATED)
MAINTENANCE BUILDING
ADMINISTRATION BUILDING
GATEHOUSE & WEIGH SCALES
ORGANIC TANK TRUCK UNLOADING AREA
INCINERATOR WASTE RECEIVING TANKS
SEGREGATED ORGANIC STORAGE TANK AREA
PIPERACK
MAIN SUBSTATION
FUEL OIL TANKS
TRUCK HOLDING AREA (INORGANIC)
TRUCK HOLDING AREA (ORGANIC)
TEMPORARY TRUCK HOLDING AREA (ORGANIC)
PHYSICAL/CHEMICAL STORAGE TANK AREA
PHYSICAL/CHEMICAL TREATMENT PLANT
SOLIDIFICATION PLANT
RECYCLE WATER POND
PIPERACK
EVAPORATOR / RECYCLE PUMP HOUSE
EVAPORATOR FEED POND
EMERGENCY ROAD, HYDRO & GAS CORRIDOR
CAR PARK
TEMPORARY TRUCK HOLDING AREA (INORGANIC)
INORGANIC TANK TRUCK UNLOADING AREA
INORGANIC DRUM STORAGE & HANDLING BUILDING
EVAPORATOR STACK
SOLIDIFIED MATERIAL INTERIM STORAGE BUILDING
SOLIDIFIED MATERIAL CONVEYOR
TRUCK LOAD OUT STATION
EFFLUENT STORAGE TANKS
SCHRAM ROAD
N

FIGURE 12 PERSPECTIVE OF CENTRAL OPERATING AREA

The following subsections contain point-form lists of facility characteristic assumptions which could potentially result in impacts on the biological resources of the site, site vicinity, facility servicing corridors, and Welland River study areas. A detailed summary of facility characteristics assumptions are contained in the site assessment report prepared by M.M. Dillon Limited (1987b).

4.1 PHYSICAL-CHEMICAL TREATMENT PLANT

- clearing of site vegetation will be carried out to allow construction of all components of the treatment plant;
- equipment noise and dust will be generated during construction activities (earth moving, vehicular movements);
- noise will be generated by the facility during operations (at lower levels but for longer duration than during construction).

4.2 INCINERATOR

- clearing of site vegetation will be carried out to allow construction of the incinerator;
- equipment noise and dust will be generated during construction activities (earth moving, vehicular movement);
- noise will be generated by the facility during operations (at lower levels but for longer duration than during construction);
- a 60 m high incinerator stack will be constructed;

- the incinerator stack will be lit in accordance with Transport Canada requirements (i.e., two red flashing hazard beacons and two red steady burning obstruction lights).

4.3 LANDFILL

- the engineered landfill will be of the "shallow entombed" type;

- landfilling will occupy a considerable proportion of the site and will suround the central operating area (physical/chemical treatment plant, incinerator, laboratory and administration buildings), with a 50 m buffer zone between the site boundary and the landfill;

- vegetation clearing, grading and excavation will be required as part of landfill development;

- landfilling will be carried out on a continuous, as-needed basis, commencing in the southeast quadrat of the site and proceeding in a clock-wise fashion around the Central Operating Area;

- equipment noise and dust will be generated during landfill excavation activities (earth moving, vehicular movements). Noise levels associated with landfill activities will be greater than levels associated with construction activities and plant operations.

4.4 FACILITY SERVICING OPTIONS

- construction of a natural gas pipeline from Vineland to the site via Regional Road 24/Highway 20/Schram Road (Consumers Gas 1987);

- construction of a 115 kV hydro transmission line to the site from an existing transmission corridor north of the site, south via Silverdale Road (Ontario Hydro 1987);
- construction of process water intake line and pumphouse from the Welland River to the site via Heaslip Road;
- construction of a storm water discharge line from the site to the Welland River via Heaslip Road;
- realignment of Schram Road south of Highway 20 to eliminate the undesirable "jogged" intersection with Silverdale Road.

4.5 SURFACE WATER DRAINAGE

- construction of internal perimeter ditching surrounding the site to collect on-site surface runoff;
- alteration of existing surface water drainage patterns on-site;
- construction of storm water retention ponds and fire water ponds;
- construction of external perimeter ditching to divert surface drainage around the site.

4.6 FENCING AND BERMING

- construction of a 3 m high chain link security fence topped with barbed wire to completely surround and enclose the facility;

- construction of an undulating 2-5 m high berm around three sides of the facility (north, east, south) inside the perimeter fencing.

4.7 CONSTRUCTION ACTIVITIES

- facility construction will involve vegetation removal, earth moving, noise and dust generation, surface drainage alteration and temporary settling pond construction, and access road, security fence and berm construction. Noise levels associated with construction activities will be greater and of shorter duration than levels associated with plant operations but less than expected levels associated with landfilling operations.

4.8 OPERATIONAL AND MAINTENANCE ACTIVITIES

- facility operation and maintenance will involve the presence of storm water retention and fire ponds, the presence of incinerator and evaporator stacks, and uncontaminated surface water discharge;

- stack lighting at night;

- noise generated by plant operations;

- emissions from the incinerator stack, emissions from the evaporator stack, and fugitive atmospheric emissions (see Environ Corporation (1987) and Ontario Research Foundation (1987));

- revegetation of berms and landfill areas.

4.9 POST-OPERATIONAL ACTIVITIES

- site decommissioning will result in the dismantling and removal of the plant (including stacks);

- security fencing will be maintained around the perimeter of the site to restrict access;

- landfill areas will be covered by a compacted clay cover with topsoil and revegetated, shaped into a network of shallow swales draining to perimeter ditches (pre-development flow levels in 9C Creek will not be restored);

- the former Central Operating Area will be resurfaced with clean fill, vegetated and shaped into shallow swales to match the established surface drainage pattern of the landfill.

5.0 IMPACT PREDICTION

5.1 INTRODUCTION

This section of the report provides an assessment of impacts on the biological resources of the preferred site and site vicinity associated with the proposed construction and operation of the OWMC 300,000 t/a facility. The prediction of impacts has been made on the basis of the existing site and site vicinity biological conditions (as described in Section 3.0) and our understanding of facility characteristics (proposed layout, construction and operational activities), as described in Section 4.0.

From a biological perspective, facility expansion from 150,000 to 300,000 t/a capacity and the subsequent increase in waste throughput will not result in different impacts. Biological impact assessment was therefore based on the 300,000 t/a facility.

Impact prediction involved determining the likelihood of certain changes occurring in the biological environment during three stages of the project: construction, operations and post-operations. Predictions concerning the specific impacts described in Section 5.3 are based in part on quantitative calculations or measurements, and in part on professional judgement.

5.2 SCOPE AND OBJECTIVES

Phase 4B of the OWMC Site Assessment Study involves the assessment of impacts associated with the proposed undertaking. This section of the report assesses and describes potential impacts on biological resources both on-site and off-site, with the exception of those impacts associated with gaseous emissions from the incinerator and evaporator stacks. The latter impacts are addressed by Environ Corporation (1987).

The specific objectives of the impact prediction component of the site assessment study were:

(1) To develop and apply an analytical process which would identify potential biological impacts associated with the undertaking;

(2) To predict biological impacts both with and without the application of mitigation measures;

(3) To determine the spatial distribution, frequency, duration magnitude, reversibility, potential for occurrence, (i.e., uncertainty), and significance of each impact identified;

(4) To recommend mitigative measures, contingency measures and monitoring approaches, and

(5) To identify residual impacts following the application of mitigation/contingency measures (i.e., net effect).

5.3 STUDY AREAS

The study areas referred to in the impact prediction, mitigation and monitoring components of the Phase 4B Site Assessment study are identical to those described in Section 1.4 and shown on Figure 4.

5.4 TIME HORIZONS

Time horizons associated with impacts, mitigation and monitoring were identified where possible. Some impacts are expected to be of short-term duration (i.e., occurring only during the facility construction phase), while others may extend over the operating life of the landfill component of the facility (minimum of 20 years) and beyond.

Mitigation options range from short-term measures designed to avoid/reduce specific, localized impacts during the construction and operations stages, to long-term measures intended to take effect during and following site decommissioning (post-operations stage).

Much of the recommended monitoring program is designed to take repetitive measurements of certain biological parameters/indicators over a time period which commences during the preconstruction stage, continues throughout the construction and operations stages, and extends beyond the minimum 20-year life of the landfill component of the OWMC facility to include the post-operations stage (site decommissioning and post-closure).

5.5 FACTORS AND INDICATORS

Two biological impact factors, (1) impacts on ecosystem structure and (2) impacts on ecosystem function, were selected to focus the impact analysis. These factors provide the organizational framework within which data concerning biological impacts are presented. Definitions, rationale and the significance of each impact factor are provided in Table 14.

Biological impact factors were selected on the basis of their ability to contribute to achieving Phase 4B biology study objectives (3) through (5), as listed in Section 1.1. These two factors also relate to OWMC's site selection goal of minimizing environmental impact (see Section 1.2).

Table 14

OWMC Phase 4B Biological Impact Factors

FACTOR	DEFINITION	RATIONALE	SIGNIFICANCE
1. Impacts on Ecosystem Structure (Components)	-project induced changes in size and form of ecosystems (e.g., reduction or loss of representative habitat, loss of rare species and rare species habitat, changes in community size and structure) -impacts measured according to hierarchical structure at 3 levels - individual - population - community -prediction of impacts on ecosystem structure based on qualitative descriptions, quantitative data, professional judgement	-allows prediction of initial outcome of perturbation within specific temporal and spatial boundaries -considers impacts at 3 stages of project: construction, operations, post-operations -establishes basic and direct linkages between project and structure of ecosystem	considers "value" or significance of components as ascribed by society -significance based largely on public perceptions - concern for human health and safety, potential loss of rare and endangered species, habitat, commercially, recreationally, aesthetically important resources ("valued ecosystem components")
2. Impacts on Ecosystem Function (Processes)	-project induced changes to ecosystem functions, processes (e.g., energy flow, nutrient cycling, primary productivity, succession) -impacts measured according to linkages, interrelationships, cause and effect relationships among ecosystem components -prediction of impacts on ecosystem function based on knowledge of ecological principles, professional judgement	-assesses full consequences of impacting activities -allows prediction of indirect impacts on ecosystem function which might result from direct changes to ecosystem structure -impacts assessed at ecosystem level - more complex than community, population levels	-significance/value of ecosystem "process" less easy to define than "components" -values ascribed by applied ecologist rather than public -considers susceptibility of ecosystem to impacting activities -ability to withstand changes (stability, efficiency) -ability to recover from change (resiliency)

Each impact factor has been subdivided into three impact indicators. Indicators represent more specific components/ aspects of the impact factors and allow impacts to be identified and described in a more precise manner. The biological impact factors and impact indicators used in Phase 4B are listed below:

BIOLOGICAL IMPACT FACTORS	BIOLOGICAL IMPACT INDICATORS
A. Impacts on Ecosystem Structure	1. Rare and Significant Species
	2. Plant and Animal Community Structure and Representativeness
	3. Plant and Animal Habitat
B. Impacts on Ecosystem Function	1. Ecosystem Efficiency
	2. Ecosystem Stability
	3. Ecosystem Resilience

Phase 4B factors and indicators differ considerably from those used in Phase 4A. In Phase 4A, factors and indicators were used as the basis for a comparative evaluation of siting options; in Phase 4B they contributed solely to the prediction of impacts associated with the preferred siting option. The three indicators of the "ecosystem structure" factor represent variants of biological factors used for the comparative evaluation of siting options (i.e., candidate sites) in Phase 4A.

Two of the three indicators of the "ecosystem structure" factor represent biological resources which are among those considered significant according to societal perceptions (Beanlands and Duinker 1983). These public concerns are referred to as "valued ecosystem components" and include the following:

- loss of rare or endangered species; and
- potential loss of habitat.

Two indicators of the "ecosystem structure" factor (1 and 3) acknowledge the significance of these two concerns.

A schematic representation of the major structural components of the preferred site and site vicinity ecosystem is provided in Figure 13.

The three indicators of the "ecosystem function" factor consider linkages, pathways and interrelationships among the various ecosystem components.

Ecosystem efficiency involves the notion of maintaining net productivity, energy capture, energy flow to each trophic level, and nutrient cycling.

Ecosystem stability considers the ability of the ecosystem to withstand changes or perturbations and relates to such functions as the maintenance of trophic web complexity, species diversity, and interspecific (i.e., predator-prey, host-parasite) relationships.

Ecosystem resilience considers the ability of the ecosystem, once destabilized, to recover to a state of ecological efficiency. Generally speaking, naturally stable environments are ones in which complex and finely balanced ecosystems exist, whereas naturally unstable environments may be structurally more simple, and thus their ecosystems are more resilient (Walker and Norton 1982).

5.6 IMPACT PREDICTION PROCESS

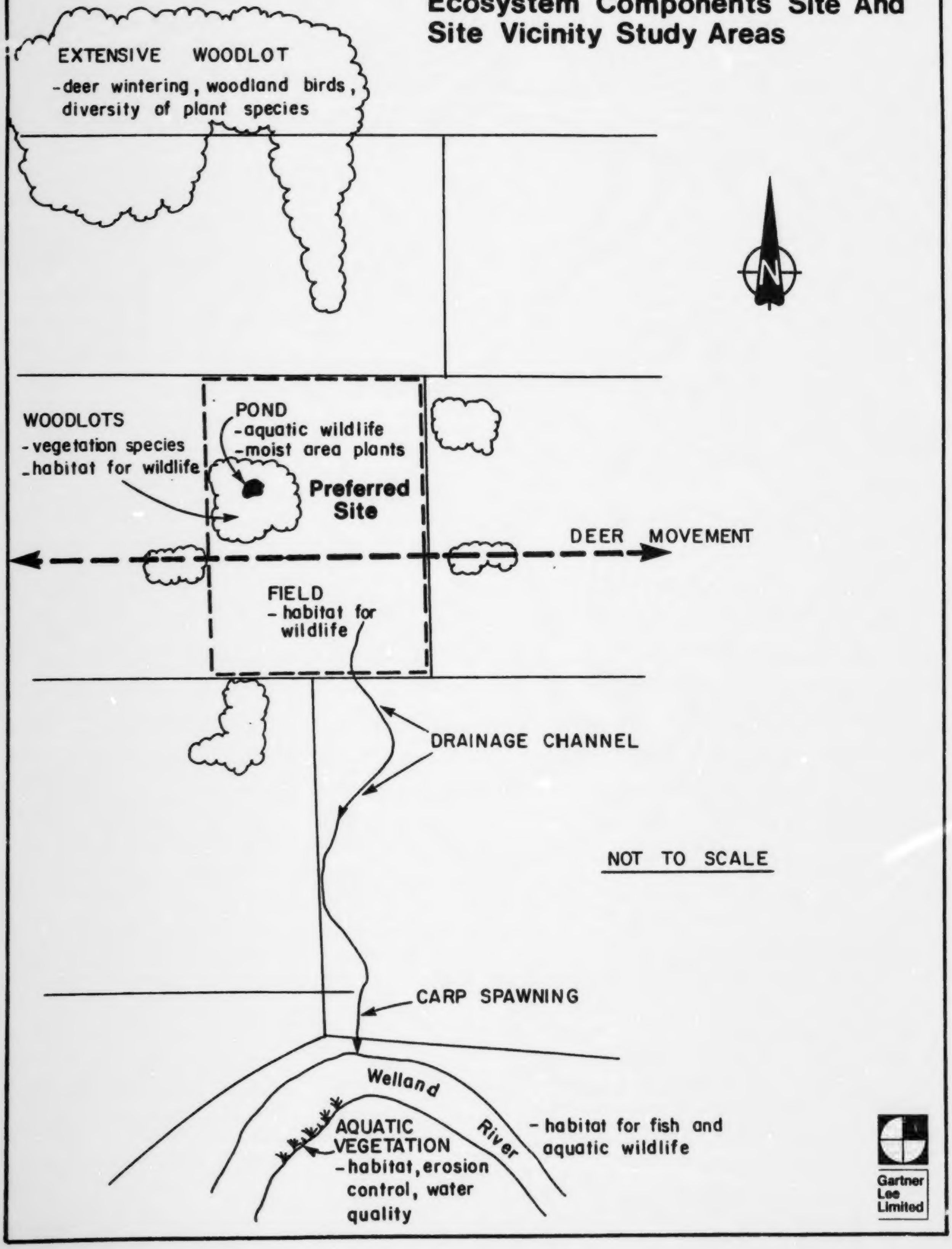
Impact prediction involved several major steps. The sequence of steps followed is shown in Figure 14.

Data collected during previous phases of the study provided the basis for the impact prediction analysis.

A detailed description of existing biological conditions on the site and the site vicinity was primarily obtained from field data collected during 1986 (see Section 3.0). This provided a framework within which characteristics of the proposed OWMC facility could be considered. Establishing linkages between existing biological conditions and facility characteristics allowed a determination of potential impact agents (proposed actions of the undertaking which represent potential causes of an impact) and impact receptors (components of ecosystem structure/function upon which an impact agent is acting).

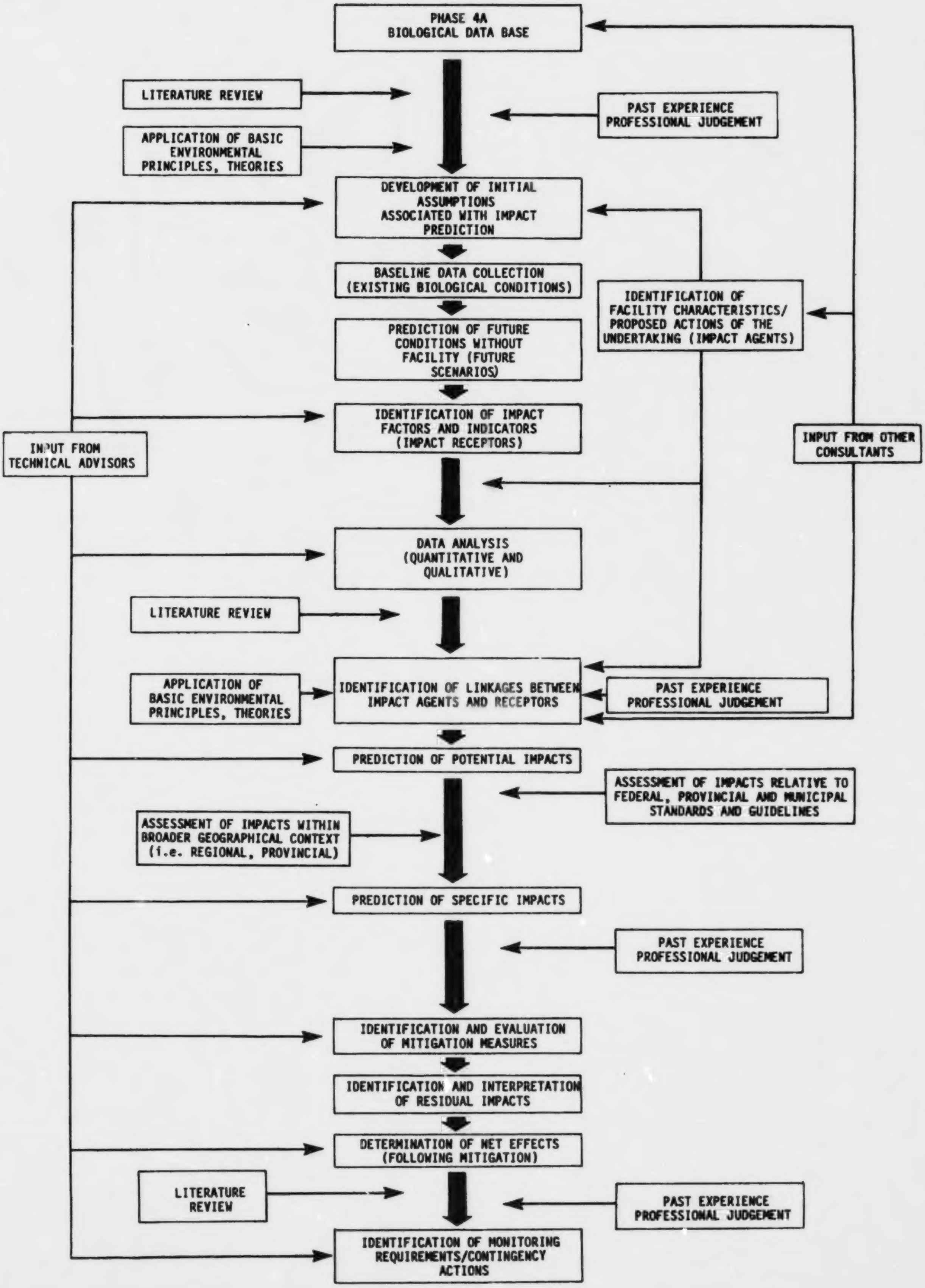
Impact data tables were subsequently compiled. These tables are based on the two biological impact factors and indicators and provide brief descriptions of the nature of each potential impact identified. Consideration is given to impacts which might arise as a result of facility construction and/or operations. These tables also indicate whether the impact is expected to have an effect on the biological resources of the site, the site vicinity, facility servicing corridors, or the Welland River. Potential impacts are identified by linking each of the six impact indicators (impact receptors) listed down the left-hand side of the tables with each action of the proposed undertaking (impact agents). Impact agents are listed

Figure 13
Ecosystem Components Site And Site Vicinity Study Areas


EXTENSIVE WOODLOT
-deer wintering, woodland birds, diversity of plant species
WOODLOTS
-vegetation species
-habitat for wildlife
POND
-aquatic wildlife
-moist area plants
Preferred Site
DEER MOVEMENT
FIELD
- habitat for wildlife
DRAINAGE CHANNEL
NOT TO SCALE
CARP SPAWNING
Welland River
- habitat for fish and aquatic wildlife
AQUATIC VEGETATION
-habitat, erosion control, water quality
N

Gartner Lee Limited

FIGURE 14: PHASE 4B BIOLOGICAL IMPACT PREDICTION PROCESS


PHASE 4A
BIOLOGICAL DATA BASE
LITERATURE REVIEW
PAST EXPERIENCE
PROFESSIONAL JUDGEMENT
APPLICATION OF BASIC ENVIRONMENTAL PRINCIPLES, THEORIES
DEVELOPMENT OF INITIAL ASSUMPTIONS ASSOCIATED WITH IMPACT PREDICTION
BASELINE DATA COLLECTION (EXISTING BIOLOGICAL CONDITIONS)
IDENTIFICATION OF FACILITY CHARACTERISTICS/ PROPOSED ACTIONS OF THE UNDERTAKING (IMPACT AGENTS)
PREDICTION OF FUTURE CONDITIONS WITHOUT FACILITY (FUTURE SCENARIOS)
IDENTIFICATION OF IMPACT FACTORS AND INDICATORS (IMPACT RECEPTORS)
INPUT FROM TECHNICAL ADVISORS
INPUT FROM OTHER CONSULTANTS
DATA ANALYSIS (QUANTITATIVE AND QUALITATIVE)
LITERATURE REVIEW
APPLICATION OF BASIC ENVIRONMENTAL PRINCIPLES, THEORIES
IDENTIFICATION OF LINKAGES BETWEEN IMPACT AGENTS AND RECEPTORS
PAST EXPERIENCE
PROFESSIONAL JUDGEMENT
PREDICTION OF POTENTIAL IMPACTS
ASSESSMENT OF IMPACTS RELATIVE TO FEDERAL, PROVINCIAL AND MUNICIPAL STANDARDS AND GUIDELINES
ASSESSMENT OF IMPACTS WITHIN BROADER GEOGRAPHICAL CONTEXT (i.e. REGIONAL, PROVINCIAL)
PREDICTION OF SPECIFIC IMPACTS
PAST EXPERIENCE
PROFESSIONAL JUDGEMENT
IDENTIFICATION AND EVALUATION OF MITIGATION MEASURES
IDENTIFICATION AND INTERPRETATION OF RESIDUAL IMPACTS
DETERMINATION OF NET EFFECTS (FOLLOWING MITIGATION)
LITERATURE REVIEW
PAST EXPERIENCE
PROFESSIONAL JUDGEMENT
IDENTIFICATION OF MONITORING REQUIREMENTS/CONTINGENCY ACTIONS

across the top of the tables as column headings. Situations in which a given impact agent is expected to have no impact on a given impact receptor are also acknowledged.

The specific locations of impact agents and receptors and, where possible, the approximate geographic extent of each impact were delineated on a 1:5,000 photomosaic base map of the site and a 1:10,000 photomosaic base map of the site, site vicinity and Welland River.

Once potential impacts had been identified, an assessment was made of the frequency, duration, magnitude, reversibility, potential for occurrence, and significance of each. To aid in the interpretation of important terms used for the purpose of the Phase 4B biological impact assessment, the following definitions are provided:

- STAGE OF DEVELOPMENT
  - Pre-construction - monitoring of biological conditions prior to facility construction.
  - Construction - activities carried out during site development period following project initiation.
  - Operations - activities occurring during the expected life of the facility (20 or more years), following construction.
  - Post-Operations - activities occurring during and following closure and decommissioning of the facility.

- **FREQUENCY**

- Constant	- 8 hours a day, 5 days a week (construction stage). - 24 hours a day, 7 days a week (operations/post-operations stages).
- Intermittent	- periodic, seasonal; specific time frame uncertain, may occur during portion of day, week, year, etc.

- **DURATION**

- determined from the report entitled Phase 4B Site Assessment Report - Facility Characteristics (Monenco Limited 1987a) (where specified) or estimated on the basis of professional judgement.

- **MAGNITUDE**

- degree of magnitude was largely determined on the basis of professional judgement and takes into consideration the nature of the impact agent, the nature of the impact receptor, and the spatial distribution, frequency and duration of the impact.

- High	- an impact which affects a large area over a long period of time (e.g., loss of wildlife habitat on site) or results in the loss of a significant receptor (e.g., elimination of rare species on site).
- Moderate	- an impact which affects a small area over a long period of time (e.g., fencing as a barrier

to deer movement to and from the site) or results in indirect damage to a significant receptor (e.g., localized drying of soil due to perimeter ditching may impact adjacent rare plants).

- Low - an impact which affects a small area over a short period of time (e.g., localized construction damage on adjacent vegetation) or involves an impact for which the potential for occurrence is low (e.g., incinerator and evaporator stacks as obstacles to migratory birds).

- **REVERSIBILITY**

- Yes - complete reversibility of an impact possible as a result of natural change (recovery succession) and/or man's influence (applied mitigation).

- Partially - partial reversibility of an impact possible as a result of succession and/or mitigation; results in a partial return to the original (i.e., pre-development) structural/functional state of the ecosystem.

- No - reversibility of impact not possible, in spite of mitigation.

- **POTENTIAL FOR OCCURRENCE**

- potential for the occurrence of an impact was determined on the basis of professional judgement, given the construction/operations activities described in Monenco Limited (1987).

- High - certain to occur (e.g., fencing as a barrier to deer movement).

- Moderate - likely to occur but exact extent, magnitude and duration of impact not certain (e.g., construction damage to natural vegetation in facility servicing corridor right-of-ways).

- Low - least likely to occur, but may occur; exact extent, magnitude, duration and frequency of impact not certain (e.g., potential uptake of of contaminants by wildlife attracted to "potentially contaminated" storm water ponds).

• SIGNIFICANCE OF IMPACT

- Major - an impact which affects an entire population of a species within a given geographic area (e.g. Niagara Region) in sufficient magnitude to cause a decline in abundance and/or change in distribution beyond which natural recruitment (i.e., reproduction, immigration) would not return that population or any population of a species dependent upon it, to its former level. (Note: None of the potential impacts identified in this study was considered to be of "major" significance).

- Moderate - an impact which affects a portion (i.e., few individuals) of a population or community with a small regional population and distribution but a large provincial and/or national population and distribution and which has no effect or a minimal effect on other components of the community or an impact which affects a portion of a population or community with a large regional population and distribution but a small provincial and/or national population and distribution and which has no effect or a minimal effect on other components of the community (e.g., loss of Pin Oak on-site; a regionally common tree species which is rare in Ontario and Canada).

- Minor - an impact which affects a portion (i.e., few individuals) of a population or community with a large regional and provincial population and distribution (e.g., on-site removal of vegetation which is widely represented within the Niagara Region) and which has no effect or a minimal effect on other components of the community (e.g., perimeter fencing as an obstacle to deer movement across site).

5.7 ASSUMPTIONS AND LIMITATIONS

Several important assumptions were applied during the prediction of biological impacts. These are:

1. That the sequence and timing of construction activities are as described in Monenco Limited (1987).

2. That construction activities and facility/servicing operations are as described in Monenco Limited (1987). This report makes the assumption that the Central Operating Area of the site will be cleared of existing vegetation at the outset of the construction stage and that clearing of areas for landfilling will occur on a continuous, as-needed basis, commencing in the southeast quadrant of the site and continuing in a clockwise fashion around the Central Operating Area.

3. That facility layout and specifications are as illustrated on figures contained in Monenco Limited (1987).

4. That perimeter ditches will be excavated to a depth of approximately 1 m and that the landfill will be excavated to a depth of 15 m, with surplus clay material being exported off-sitre (i.e., no stockpiling).

5. That perimeter fencing will be of a sufficient height to prevent deer or other large mammals from gaining access to the site.

6. That the Schram Road realignment option will necessitate the clearing of 0.3 ha of the "Beamer Woodlot", situated on the southeast corner of the Schram Road/Highway 20 intersection.

7. That proposed alterations to the surface water drainage patterns of the site are as described in M.M. Dillon (1987a).

8. That noise levels associated with the construction and operation stages of the OWMC facility are as described by S.S. Wilson Limited (1987).

9. That biological impacts associated with gaseous emissions emanating from the facility are addressed by Environ Corporation (1987) as part of the Environmental Risk Assessment.

10. That the following facility servicing corridors: storm water, water supply, auxiliary fuel (natural gas), site access road and Schram Road/Silverdale Road intersection realignment are as described in M.M. Dillon Limited (1987b) and that sanitary sewage will be trucked off-site to an appropriate treatment facility.

11. That biological impacts associated with the construction of a hydro line from an existing transmission corridor to the preferred site is presently being addressed by Ontario Hydro (1987) as part of a separate analysis.

Limitations to the overall Phase 4B biology study are presented in Section 1.7 of this report. None of these limitations, however, is thought to interfere with achieving the specific objectives of the impact prediction component of this study, as listed in Section 5.2.

5.8 RESULTS OF IMPACT PREDICTION ANALYSIS

Results of the Phase 4B biological impact assessment are summarized in three tables (Tables 15, 16 and 17) and on two maps (Figure 15 (back pocket) and Figure 16). Table 15 contains a summary of potential biological impacts associated with the construction stage of the OWMC facility and Table 16 contains a summary of potential biological impacts associated with the operations and post-operations stages. Table 17 provides a

TABLE 15 : SUMMARY OF POTENTIAL BIOLOGICAL IMPACTS ASSOCIATED WITH FACILITY CONSTRUCTION STAGE
(S = SITE, V = SITE VICINITY, F = FACILITY SERVICING CORRIDORS, W = WELLAND RIVER)

BIOLOGICAL FACTOR INDICATORS (IMPACT RECEPTORS)	ACTIONS OF THE PROPOSED UNDERTAKING (IMPACT AGENTS)								
	VEGETATION REMOVAL - SITE	VEGETATION REMOVAL, CONSTRUCTION DAMAGE - SITE VICINITY	PERIMETER DITCHING	FENCING	NOISE	DUST DISPERSAL, EARTH MOVING AND VEHICLE TRAFFIC	DRAINAGE ALTERNATIONS (RE-ROUTING OF 9C CREEK)	GAS PIPELINE FROM VINELAND, OUTFALL TO WELLAND RIVER VIA HEASLIP ROAD	PUMPHOUSE ON WELLAND RIVER AT HEASLIP ROAD
Rare and Significant Species	S Removal of : - Pin Oak : 6 stems - Black Gum : 2 clumps - Wood's Sedge : a few stems - Small Bedstraw : 10 stems - Southern Arrow-wood : numerous - Blunt-leaved Sandwort : unknown number of individuals	V Potential crown & stem damage to : - Black Gum : 31 saplings 75 seedlings - Canada Plum : 1 stem - Southern Arrow-wood : numerous in woods adjacent to west centre of site	V Potential moisture stress on : - Black Gum : 31 saplings 75 seedlings - Canada Plum : 1 stem - Southern Arrow-wood : numerous	No Impact	No Impact	V Potential damags to rare species due to dust deposition on : Black Gum : 31 saplings 75 seedlings Canada Plum : 1 stem Southern Arrow-wood : numerous in woods adjacent to west-centre of site	No Impact	No Impact	No Impact
Community Structure	S Entire on-site vegetation community eliminated : 382 plant species - loss of hibernating mammals, reptiles & amphibians - displacement of winter bird, mammal community	V - new edge will be exposed in woods adjacent to west-centre of site : resultant change in structure of that edge via succession - reduction in woodlot size will result in reduction of wildlife diversity	V Local drying trends in woods near ditching, particularly woods on west-centre site edge	S,V - prevents movement of mammals (larger than squirrels) from immigrating to/emigrating from site V - forces White-tailed Deer moving east/west to use routes north of Hwy 20 / south of Vaughan Rd.	V - elevated noise levels may interfere with detection of bird song, frog chorusing - potential for minor impact on reproductive capability of birds, amphibians	V - Edge communities will be the receptor of most of the dust accumulation on plant foliage - Potential loss or damage to wildlife edge habitat	V - hydrophyllic vegetation in 9C Creek bottom may be gradually replaced by drier community - reduced flow in 9C Creek, minor impact on aquatic wildlife downstream - less water to support forage fish	F,V Removal of or damage to roadside vegetation F,V displacement of wildlife W,V increased discharge to Welland River, possible change in water temperatures at outfall W,V minor, local impact on fish community	F,V - removal of or damage to roadside vegetation - displacement of wildlife
Habitat Area	S - Removal of 60 hectares of : dry-mesic, mesic & wet-mesic woods; thicket, marsh, old and recently disturbed fields - Loss of habitat for breeding and migrant wildlife	V - potential shift from woodland to thicket may occur where new edge community develops - woods adjacent to Schram Rd., woods adjacent to west-centre of site - Schram Rd. alignment option will result in loss of 0.3 ha of deciduous woodland - will result in loss of several pairs of common breeding birds	V Minor changes in habitat possible eg. trend towards dry woods from dry-mesic	S - isolates site from surrounding area V - removes "link" in chain of small woodlots south of Hwy 20	No Impact	V - increased sedimentation of 9C Creek prior to construction of perimeter drainage ditches - minor impact on aquatic life	V - change from wetland habitat to drier field community S - loss of headwater portion of 9C Creek V - barrier to upstream movement of aquatic wildlife at Vaughan Road	F,V - damage to or removal of some thicket, hedge-row or marsh - loss of wildlife habitat	F,V - removal of thicket vegetation communities - displacement of wildlife
Ecosystem Efficiency	S - productivity of plant & animal biomass reduced to zero - change to balance of trophic levels - resource utilization efficiency reduced to zero	V - damage from tree removal on adjacent woods (off-site) could reduce efficiency of those species (eg. through potential crown damage)	No Impact	No Impact	V - reduced productivity of adjacent wildlife - reduced efficiency of wildlife community - very minor impact	V - decreased diffusion and photosynthetic capacity of vegetation exposed to higher potential dust levels - decreased productivity, efficiency	No Impact	No Impact	No Impact
Ecosystem Stability	S - elimination of available niches for wildlife through habitat loss - reduction in carrying capacity - lower population densities - more generalists, fewer specialists - considerable overall reduction in stability	V - overall reduction in stability	V - may result in instability in adjacent woodlots as species adjust or are replaced over time	No Impact	No Impact	No Impact	V Short term instability	No Impact	No Impact
Ecosystem Resilience	S - disturbed fields currently on site will regenerate quickly after construction on areas such as completed landfill cells and road margins - no resilience of forest, thickets, wetland habitats	V - new edge vegetation community will arise on adjacent woodlots	V - response to moisture change through species replacement - drier species will dominate ground cover	No Impact	No Impact	No Impact	V Replacement of wet mesic species with mesic species likely rapid due to available seed source (banks of ditch)	V,F - coppice growth will be rapid from remnant stumps - high resilience	No Impact

TABLE 16 : SUMMARY OF POTENTIAL IMPACTS ASSOCIATED WITH FACILITY OPERATIONS AND POST-OPERATIONS STAGES
(S = SITE, V = SITE VICINITY)

BIOLOGICAL FACTOR INDICATORS (IMPACT RECEPTORS)	ACTIONS OF THE PROPOSED UNDERTAKING (IMPACT AGENTS)				
	DUST MOVEMENT, EARTH STOCKPILING AND VEHICLE TRAFFIC	INCINERATOR, EVAPORATOR STACKS	FENCING	NOISE	SURFACE WATER PONDS
Rare and Significant Species	V Potential damage to rare species due to dust deposition on : Black Gum : 31 saplings 75 seedlings Canada Plum : 1 stem Southern Arrow-wood : numerous adjacent to west centre of site	No Impact	No Impact	No Impact	No Impact
Community Structure	V - Edge communities will be the receptor of most of the dust accumulation on plant foliage - Potential loss or damage to wildlife edge habitat - Change in representativeness of biotic community	S - obstacles to migratory birds (especially nocturnal migrants) - proposed lighting of stacks may be an attractant to birds	Same as Construction Phase	Same as Construction Phase	S - attractant to aquatic wildlife; - positive impact - provides feeding area; - negative impact - contaminants in "potentially contaminated pond", attraction of nuisance wildlife
Habitat Area	No Impact		Same as Construction Phase	No Impact	S - positive impact - provides potential habitat for aquatic wildlife
Ecosystem Efficiency	V - decreased diffusion and photosynthetic capacity of vegetation exposed to higher potential dust levels - decreased productivity, efficiency	No Impact	No Impact	Same as Construction Phase	No Impact
Ecosystem Stability	V - change in representativeness, reduction in ecosystem efficiency will result in reduced stability	No Impact	No Impact	No Impact	No Impact
Ecosystem Resilience	V - sensitive species may be replaced by tolerant species	No Impact	No Impact	No Impact	No Impact

TABLE 17 : SUMMARY OF SPECIFIC BIOLOGICAL IMPACTS IDENTIFIED IN TABLES 15 AND 16

IMPACT AGENT	IMPACT RECEPTOR	DEVELOPMENT STAGE	NATURE OF IMPACT	SPATIAL DISTRIBUTION	FREQUENCY AND DURATION	MAGNITUDE	REVERSIBILITY	POTENTIAL FOR OCCURRENCE	SIGNIFICANCE OF IMPACT	COMMENTS
Vegetation Removal	rare plant species on-site	construction	displacement of 6 rare species	in northwest quadrat of site	constant over 3 months	high	partially through mitigation (e.g. transplanting)	high	moderate	1 high significance species: Querus palustris, 5 medium significance species: Galium trifidum, Nyssa sylvatica, Viburnum recognitum, Arenaria lateriflora Carex tetanica
Vegetation Removal	Hibernating mammals, reptiles and amphibians	construction	loss of unknown number of individuals	throughout site, primarily in woodlots, wet thickets	constant over 3 months	moderate	no	moderate	minor	
Vegetation Removal	vegetation communities and habitat area	construction	elimination of 60 ha representing 7 habitat types : - dry-mesic, mesic and wet-mesic woods, thicket, marsh, recently disturbed and old fields	entire site	constant over 3 months	high	partially through site landscaping	high	minor	
Vegetation Removal	resident and migrant wildlife communities	construction, operations	wildlife displacement through loss of 124 ha of habitat	throughout site	constant over life of facility	high	partially through mitigation and/or vegetation succession	high	minor	
Vegetation Removal	hedgerow, roadside trees and marsh communities	construction	removal or damage to common plant species. Loss of wildlife habitat	Hwy. 20, Reg. Rd. 24, and Heaslip Road right-of-ways, pump house location	constant over 8 months	low	partially through roadside landscaping	moderate	minor	
Vegetation Removal	trees, shrubs, several pairs of breeding birds	construction, operations, post-operations	removal of vegetation associated with Schram Road alignment option (if chosen)	0.3 ha of deciduous woodland, corner of woodlot adjacent to Schram Road	constant, permanent	low	partially through roadside landscaping	high	minor	
Vegetation Removal	wildlife, vegetation community	construction, operations, post-operations	reduction in primary productivity, imbalance of trophic levels, reduction in resource utilization, overall reduction in efficiency of ecosystem; reduction in habitat diversity resulting in increased competition for habitat, food; overall reduction in ecosystem stability; reduction of ecosystem stability leads to structural simplicity, greater resilience	throughout site	constant, over life of facility and beyond	high	partially through mitigation and/or vegetation succession	moderate	minor	
Vegetation - Construction Damage	adjacent vegetation community, including 3 rare plant species adjacent to site	construction	physical damage to adjacent vegetation through tree-felling, etc. (e.g. crown damage)	communities adjacent to west edge of site	constant over 3 months	low	partially through mitigation	moderate	minor	2 medium significance species: Nyssa, Viburnum 1 low significance species: Prunus nigra

TABLE 17 (cont'd) : SUMMARY OF SPECIFIC BIOLOGICAL IMPACTS IDENTIFIED IN TABLES 15 AND 16

IMPACT AGENT	IMPACT RECEPTOR	DEVELOPMENT STAGE	NATURE OF IMPACT	SPATIAL DISTRIBUTION	FREQUENCY AND DURATION	MAGNITUDE	REVERSIBILITY	POTENTIAL FOR OCCURRENCE	SIGNI- FICANCE OF IMPACT	COMMENTS
Erection of Fencing	Larger Mammals (e.g. deer)	construction, operations, post-operations	prevents immigration to, emigration from site by large mammals; removes portion of E-W wildlife corridor between Highway 20 and Vaughan Rd.	entire site	constant, over life of facility and beyond	high	no (will remain after closure of facility)	high	minor	
Drainage Alterations 9C Creek	current tributary channel downstream (south) of site	construction, operations, post-operations	shift in community structure from a wet community to mesic	9C Creek bottom south of site; impact likely greatest in approximately first 150 metres of Creek	constant from drainage diversion until community stability	low	partially through mitigation	moderate	minor	
Drainage Alterations - Perimeter Ditching	aquatic wildlife (amphibians, fish, muskrats)	construction, operations, post-operations	barrier to upstream movement of aquatic wildlife	Headwater portion of 9C Creek	constant, permanent	moderate	yes, if barrier removed after closure of facility	moderate	minor	
Perimeter ditching	vegetation adjacent to site, including 3 rare plant species	construction, operations	localized drying trend will shift community structure in watertable drawdown zone along ditch and may stress woodland community supporting 3 rare species	along entire western edge of site (including woodlot containing 3 rare plant species	constant over 9 months and beyond until community stabilizes	low	partially through mitigation	low	minor	2 medium significance species: Nyssa, Viburnum 1 low significance species: Prunus
Heaslip Road Stormwater Sewer Outfall/ Water Intake	fish community	operations	surface water discharge - increased volume, change in temperature, Dissolved Oxygen levels - potential impact on fish community	localized at mouth of outflow Welland River	intermittent over life of facility	low	partially through mitigation	moderate	minor	
Incinerator, Evaporator, Boiler Stacks	migratory birds	operations, post-operations	obstacles to migratory birds; lights on stacks act as potential attractant	site (south and central portions)	intermittent (nocturnal) over life of facility and beyond	low	yes (stacks will be removed after closure)	low	minor	
Surface Water Ponds	migratory water-birds, amphibians, aquatic mammals, fish	operations, post-operations	attractant to aquatic wildlife; positive impact : provides feeding area; negative impact : potential for uptake of contaminants in potentially contaminated pond, attraction of nuisance wildlife (e.g., muskrats, gulls, geese)	south end of site	constant over life of facility and beyond	low	yes, if wildlife prevented from gaining access to ponds	low	minor	
Dust Dispersal	adjacent vegetation (including 3 rare plant species	construction and operations	dust accumulation on vegetation with subsequent decrease in diffusion and photosynthetic efficiency of edge vegetation	concentrated on nearest adjacent vegetation	constant throughout construction and operations stages	low	partially through mitigation	low	minor	2 medium significance species: Nyssa, Viburnum 1 low significance species: Prunus
Earth Moving	aquatic wildlife and fish	construction	increased sedimentation 9C Creek - impact on aquatic invertebrates	9C Creek downstream of site to Welland River	constant over 3 months	low	partially through mitigation	moderate	minor	
Noise	wildlife community and ecosystem efficiency	construction, operations	possible interference with detection of bird song, frog choruses due to elevated noise levels during construction, and operations; reduced productivity of wildlife	localized at boundary of site (construction), within 200 m of site (operations)	intermittent, life of facility	low	partially through mitigation	low	minor	

determination of the spatial distribution, frequency, duration, magnitude, potential for occurrence, reversibility, and significance of each impact. Definitions of the various terms used in Table 17 are given in Section 5.6. Figure 15 illustrates the spatial distribution of impacts expected to occur on the site and on properties adjacent to the site. Figure 16 illustrates the spatial distribution of impacts expected to occur elsewhere in the site vicinity and in the Welland River.

Thirty-four potential biological impacts associated with the construction stage of the proposed OWMC facility were identified (Table 15). Twelve biological impacts which might arise as a result of facility operations and/or during the post-operations stage, including four which are expected to be the same as in the construction stage, are identified in Table 16. This overall total of 46 potential impacts was aggregated into 18 specific biological impacts, each of which is discussed in greater detail in Table 17. Aggregation was necessary to account for duplication of impacts (e.g., in cases where similar impacts are expected to occur during both the construction and operations stages and where one impact agent affects several impact receptors) and to assist in focussing the discussion of impacts.

Of the 18 specific impacts assessed in Table 17, one is considered to be of "moderate" significance. The remaining 17 have all been assigned a "minor" significance rating. Generally speaking, these minor impacts are expected to occur locally and affect few individuals of species or communities with large populations and distributions. They may also be of low frequency and short duration, have a low potential for occurrence and are capable of being reversed, either wholly or partially, through mitigation and/or natural processes.

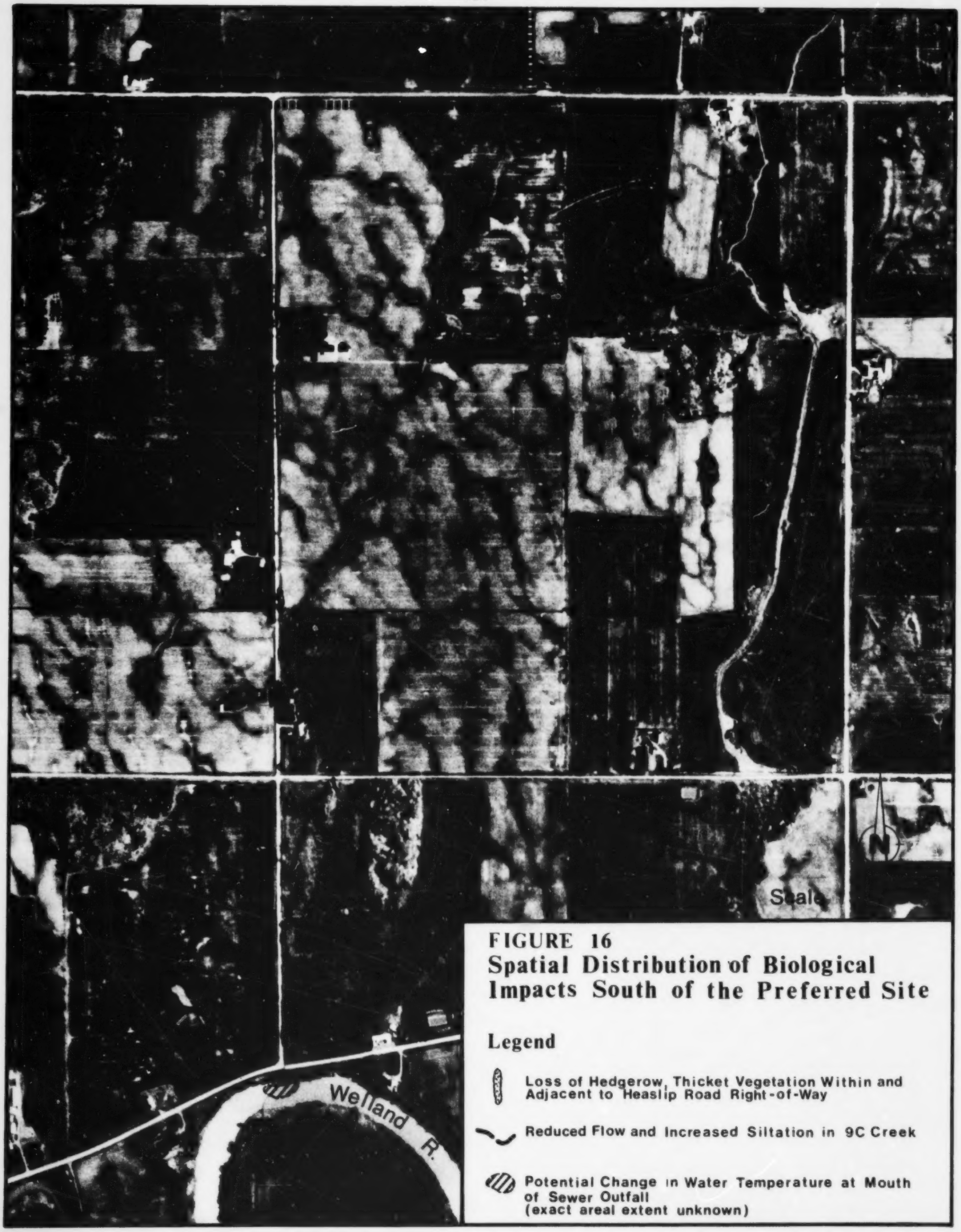

Welland R.
Scale
N
Legend
Loss of Hedgerow, Thicket Vegetation Within and Adjacent to Heaslip Road Right-of-Way
Reduced Flow and Increased Siltation in 9C Creek
▨ Potential Change in Water Temperature at Mouth of Sewer Outfall (exact areal extent unknown)

FIGURE 16
Spatial Distribution of Biological Impacts South of the Preferred Site

The results of the Phase 4B biology impact prediction analysis reveal that 8 of the 18 specific impacts are expected to occur on the preferred site and the remainder off-site. No impacts are expected to occur in any of the three Significant Environmental Units (SEUs) which occur in the site vicinity (see Section 3.5.1; Figure 11). Similarly, no biological impacts are expected to occur in either Beaver Creek or Sucker Creek.

The upstream portion of 9C Creek will be lost through surface water drainage alterations on-site. This will result in a reduction of downstream flow (see M.M. Dillon Limited 1987a). Increased siltation may occur in this watercourse during vegetation removal and earth moving activities on-site (Figure 16).

Impacts associated with the biological resources of the Welland River are expected to be of very minor significance and confined to a small area (e.g., near the mouth of the storm sewer outfall; see Figure 17).

With the exception of three rare plant species found immediately adjacent to the western edge of the site (Figure 16), none of the other rare species and/or significant biological resources identified in the site vicinity (see Section 3.5; Figure 11) is expected to be affected by the activities assessed in this report.

The remaining potential impacts identified off-site involve those which are of minor significance and occur locally, (e.g., damage to or removal of vegetation/wildlife habitat along the Regional Road 24, Highway 20 and Heaslip Road right-of-ways).

5.8.1 PREDICTED IMPACT OF MODERATE SIGNIFICANCE

None of the impacts identified in Table 17 was considered, by definition, to be an impact of "major" significance (see Section 5.6). This section of the report addresses the one impact of "moderate" significance and provides additional information to explain the rationale for this significance designation.

The only predicted biological impact which is considered to be of "moderate" significance involves the loss of six rare plant species on-site during facility construction. The significance of this impact was determined according to the definitions provided in Section 5.6.

Three of these species are regionally common and of widespread distribution. However, by virtue of the fact that the species are of limited distribution in Ontario and Canada they are considered provincially and nationally rare. By contrast, the other three species are of widespread distribution throughout much of Ontario and elsewhere in Canada but are of limited distribution and found in low numbers within the Niagara Frontier Region and are therefore considered regionally rare.

The relative significance of each of these six rare plant species (i.e., as their occurrence on the site and/or site vicinity pertains to the Phase 4B study) was determined by means of a separate analysis, the results of which are presented in Appendix F.

Although the remaining 17 biological impacts are all considered to be of "minor" significance, the cumulative effect of several "minor" impacts associated with the same impact agent (e.g., vegetation removal on-site) cannot be discounted. The following section (Section 6.0), which deals with mitigation, discusses specific mitigative measures which could be applied to all 18 impacts identified in Table 17.

5.8.2 RELATION OF IMPACTS TO FEDERAL, PROVINCIAL AND MUNICIPAL STANDARDS AND GUIDELINES

To attain a clearer understanding of the predicted biological impacts associated with the proposed OWMC facility, a consideration of how these impacts relate to existing legal, statutory and regulatory mechanisms is necessary.

A number of impact indicators or impact receptors (i.e., the biological resources of the preferred site and site vicinity study areas) are subject to federal, provincial and municipal legislation. There are additional resources which, while not afforded legal protection under an act or by-law, are nonetheless addressed in governmental policy and guideline statements.

Since the need to comply with these laws, standards and guidelines may influence the type of mitigation which could be applied to reduce or avoid potential impacts, a discussion of pertinent legal, statutory and regulatory mechanisms presently under federal, provincial and municipal jurisdiction is provided below.

5.8.2.1 Federal

Under the Federal Fisheries Act (Government of Canada 1970), it is against the law to deposit or permit the deposit of any substance "that, if added to any water, would degrade or alter ...the quality of that water so that it is rendered... deleterious to fish or fish habitat." This would apply to the discharge of storm water into the Welland River, accidental spills of untreated waste material into watercourses and increased siltation of 9C Creek during construction, if these actions result in adverse effects on fish and fish habitat.

5.8.2.2 Provincial

Water quality impacts on biota are also addressed by the Ontario Water Resources Act (Government of Ontario 1980). This act prohibits the deposition or discharge of material into water which will impair its quality and "cause injury to any person, animal, bird or any other living thing as a result of the use or consumption of any plant, fish or other living matter or thing in the water". Unlike the Fisheries Act, the Ontario Water Resources Act considers water quality impacts on all living things, not just fish.

The Environmental Protection Act (Government of Ontario 1983) can require "restoration of the natural environment" following a spill of a pollutant. Specifically defined, this means restoring "all forms of life, physical conditions, the natural environment and things existing immediately before the spill". As a mitigative approach, such action would be classified as "rectification" (see Section 6.1 for a definition of this term).

Injury to or the destruction of shade trees growing on a boundary line between two properties is prohibited under the Trees Act (Government of Ontario 1984a) and the cutting or removal of trees growing on land covered by a Woodlot Improvement Agreement, "except in accordance with the management program under the agreement", is prohibited under the Woodlands Improvement Act (Government of Ontario 1984b). The latter provision applies to a portion of Davison's Bush, situated in the southeast corner of the site vicinity, and a conifer plantation situated in the north-central portion of the site vicinity (see Section 3.5.5.1; Figure 11).

None of the plant and animal species known to occur in the site and site vicinity study areas is considered to be an "endangered" species (OMNR 1977) and thus none is subject to the legal protection afforded by the Endangered Species Act (Government of Ontario 1971).

Wetlands identified and classified according to the provincial evaluation system (Ontario Ministry of Natural Resources and Canadian Wildlife Service 1984) as being of provincial significance (Class 1 and 2) are subject to the following provincial government guidelines:

- "every land-use planning and resource management agency should have regard for the implications of its actions on wetlands within its management area";
- "wetlands identified as having significance should be protected in Official Plans from incompatible activities wherever possible"; and
- "development in wetlands can occur under carefully considered circumstances where it can be shown that the wetland values can be managed adequately" (OMNR 1984a).

The portion of the Welland River under consideration in this study is part of a Class 1 wetland (OMNR 1985c; Figure 11) and the South St. Ann's Slough Forest (Silverdale Woodlot) is considered a Class 2 wetland (OMNR 1985b; Figure 11). Both, therefore, are identified as being wetlands of "provincial significance" (see Section 3.5.1). With the exception of the construction of a pumphouse/water intake on the north bank of the Welland River at Heaslip Road, no development or operational activity associated with the OWMC facility is expected to affect these wetland areas. Furthermore, the results of the biological impact prediction analysis suggest that any impacts resulting from the pumphouse/water intake structure will be very localized and of minor significance. The siting of this structure probably does not constitute an "incompatible activity", as set out in the guidelines (OMNR 1984a).

The South St. Ann's Slough Forest (Silverdale Woodlot) and the Northwest Boyle Forest (Davison's Bush) are two areas within the site vicinity study area which have been identified by the OMNR as Areas of Natural and Scientific Interest (Macdonald 1980).

In 1983 the OMNR developed new land use guidelines for Ontario, which included a new provincial policy for Areas of Natural and Scientific Interest (OMNR 1983b). This ANSI policy is designed to achieve that portion of the OMNR's conservation objective dealing with the protection of Ontario's natural heritage, foster the protection of provincially significant natural features and landscapes, and provide a framework for the Ministry to work cooperatively with and provide direction for other agencies and individuals to protect areas of regional and local significance.

The methods that the OMNR will use to achieve the protection and management of ANSIs is described as follows:

"A series of protection methods ranging from 'total protection' through a variety of 'partial protection' options may be applied to natural and scientific areas. Total protection will be achieved by provincial nature reserves and conservation easements, while partial protection will be provided by other park classes, conservation easements, formal and informal landowner agreements and through designations in land use plans.

The Ministry of Natural Resources will be responsible for the protection and management of all ANSIs on Crown land. The Ministry will cooperate with other government agencies, municipalities and private landowners to achieve the protection and management of provincially significant ANSIs on other public and private land. To help protect ANSIs on private lands, a property tax rebate is currently being considered for those owners who manage their lands to mutually acceptable standards." (OMNR 1987a).

5.8.2.3 Municipal

Environmentally Sensitive Areas (ESAs) are addressed in the Policy Plan of the Regional Municipality of Niagara (Regional Municipality of Niagara 1981). Stated objectives of the policy plan are "to preserve, protect and conserve environmentally sensitive areas" and "to permit only those uses which are compatible with and will not damage environmentally sensitive areas". Permitted uses in ESAs are limited to agricultural uses, forestry uses, recreational uses and rural non-farm residential uses.

Several of these permitted land uses, particularly agricultural and forestry operations, could result in vegetation removal, habitat loss and the occurrence of other associated biological impacts in ESAs.

The biological impact prediction analysis determined that the proposed undertaking is not expected to have any adverse effect on the three ESAs which occur in the site vicinity study area. This suggests that permitted changes in land use are much more likely to result in impacts on the biological resources of these areas than the OWMC facility.

Landowners in the Regional Municipality of Niagara are restricted as to what trees they may cut on their properties. Legal minimum cutting diameters have been established for most tree species, under the Region's Tree By-Law (Regional Municipality of Niagara 1982). However, Pin Oak and Black Gum, the two rare tree species encountered during the Phase 4B biology study, are not included among the species for which legal minimum cutting diameters have been established. This means that a landowner wishing to cut down individuals of either species is not constrained from doing so under municipal law.

An amendment to the Tree By-Law (Regional Municipality of Niagara 1984) permits the clearing of up to 8 ha of forest on one's property, provided that the land is used for agriculture purposes within three years.

This allowable activity potentially affects a considerable proportion of the existing wooded areas in the preferred site and site vicinity study areas. Vegetation removal could involve the loss of rare plant species, loss of habitat for rare plants and animals (including rare species), wildlife community displacement, as well as associated impacts on functional components of the ecosystem. As in the previous example, the potential for the occurrence of such impacts resulting from land use changes may be greater than those anticipated to result from the proposed undertaking.

5.8.3 IMPACTS WITHIN A REGIONAL AND PROVINCIAL CONTEXT

In order to place the biological impacts associated with the proposed OWMC facility into proper perspective, the significance of these impacts and the resource base they affect were assessed within a broader geographical context (i.e., on a regional and provincial level).

The issue of rare plant species loss due to vegetation removal on-site is considered to be the most significant of the biological impacts identified. The preferred site and site vicinity study areas contain elements of Deciduous Forest (Carolinian Zone) flora and several of these species are rare by virtue of their low population size and/or limited distribution in Ontario and Canada. Some are at or near the periphery of their North American ranges (see Section 3.2 and Appendix F).

The results of the analysis documented in Appendix F indicate that within a regional and provincial (and in some cases national) context, the eight rare plant species found in the site and site vicinity study areas are significant to varying degrees. There are, however, other natural areas in the Regional Municipality of Niagara and elsewhere in the Deciduous Forest (Carolinian Zone) of Ontario which support a greater diversity of rare plant species than the preferred site (Identification Subcommittee of Carolinian Canada 1985).

The remaining potential biological impacts (i.e., those of "minor" significance) described in Table 17 are not significant from either a regional or provincial perspective.

The areal extent of natural vegetation and wildlife habitat which would be lost as a result of site facility construction is comparable to that which might be affected by the initial site clearing activities associated with many development projects in Ontario (e.g., manufacturing plants, sanitary landfill sites, residential or industrial subdivisions). This conclusion is based on extensive experience in the field of environmental impact assessment, involving developments which are in many ways analogous to the OWMC situation.

Potential impacts on the natural environment associated with drainage alterations, noise, dust and storm water discharge from the OWMC facility are expected to occur with similar degrees of magnitude, frequency and duration as a result of other large scale developments.

5.9 SUMMARY

Eight of the 18 impacts identified in Table 17 are expected to occur in the site study area, including the one impact of "moderate" significance. We have therefore concluded that the most significant impacts associated with the undertaking will occur on the site.

The frequency, duration, magnitude, and potential for occurrence of on-site impacts are generally considered "high", whereas those affecting the biological resources of the site vicinity study area tend to be localized, of shorter duration and lesser magnitude, are more difficult to predict and are all of "minor" significance. As indicated in Section 5.8, with the exception of three rare species growing adjacent to the site, none of the significant biological features in the site vicinity (e.g., SEUs) is expected to receive impacts associated with the OWMC facility.

A consideration of the biological impacts associated with the OWMC facility within a regional and provincial context suggests that these are not likely to be greater than those associated with a development of a similar scale.

The results of the biological impact prediction analysis confirm the basic acceptability of the preferred site and fulfill the OWMC objective of minimizing environmental impacts.

5.10 PREDICTED IMPACTS AND FUTURE SCENARIOS

Section 3.6 of this report contains predictions of future biological conditions, described in the form of three possible scenarios.

Scenario 3 was considered to most accurately reflect potential future conditions. Due to changes in land use and government programs influencing the natural environment, certain changes in biological conditions are expected. The purpose of this analysis is to review how these changes would influence the prediction of potential biological impacts, which were based on existing (i.e., 1986) conditions.

On the site, we have assumed that no major land use related changes will occur between 1986 and the initiation of facility construction. After construction is initiated, OWMC activities will profoundly influence the biological resources of the site. These influences have been assessed in Section 5.8.

In the site vicinity study area, where agricultural land use will continue, the type and intensity of farm practices will influence future biological conditions. As outlined in the description of Scenario 3, certain aspects of the natural environment may improve and certain aspects may decrease in quality. Since the changes will be linked to management practices of specific landowners there is a considerable degree of uncertainty associated with these predictions.

If Scenario 3 develops, the impacts associated with the OWMC facility are expected to be very similar to those predicted elsewhere in Section 5.8 of this report. Rare plant species and off-site vegetation would be affected by the OWMC perimeter ditching and any dust generated from earth moving during landfilling. Deer movement patterns would continue to be influenced by the OWMC security fence.

If Scenario 1 (degraded environment) developed, plant and animal populations residing around the margin of the OWMC facility might be eliminated by intensive land use practices and might not exist to be affected by OWMC activities. Alternatively, OWMC generated impacts might place an added stress on any degraded natural systems which might exist. The cumulative effect of more intensive land use and OWMC influences might yield an impact scenario which is more severe in intensity and extent than that predicted in Section 5.8.

If the enhanced environmental quality predicted in Scenario 2 were to develop, OWMC might be the primary source of impact on the adjacent plant and animal life. The significance of any negative effects might be influenced by the number of significant receptors affected by OWMC, compared with the size of populations of significant receptors in the site vicinity. In this situation, the net effect of any negative OWMC impacts might be less than predicted under 1986 conditions.

In summary, it can be concluded that if Scenarios 2 or 3 develop, the current assessment provides a reasonable description of potential impacts. Scenario 3 is considered to be the most probable prediction of future conditions. If Scenario 1 develops, the natural environment on the margin of the OWMC facility might be degraded by land management practices. The types of potential impacts attributable to construction and operation of the OWMC facility are not expected to differ greatly from those already predicted. The intensity and extent of OWMC associated impacts will vary depending upon the characteristics of the natural environment created by prevailing land management practices.

6.0 MITIGATION

6.1 INTRODUCTION

The purpose of this section of the report is to develop practical strategies for minimizing the biological impacts described in Section 5.8 through mitigation.

Mitigation is a term subject to a wide variety of definitions and interpretations. For the purposes of this report, "mitigation" is broadly defined to include the following:

- prevention of an adverse impact altogether by not taking a certain action or by taking an alternative course of action;
- minimization of an impact by limiting the degree or magnitude of the action;
- rectification of the impact by repairing, rehabilitating or restoring the affected environment;
- compensation for the impact by replacing or providing a substitute for the affected environment, and
- enhancement of the affected environment to a level above pre-development conditions.

The five concepts introduced above essentially translate into two principal approaches to mitigation which were adopted in this study.

(1) impact prevention and minimization; and
(2) impact rectification, compensation and enhancement.

The primary objective of the first approach is to prevent adverse, predictable, and often irreversible trends or changes from occurring in the aquatic and terrestrial ecosystems. This is best achieved through maintaining, as much as possible, the structure and function of the ecosystems involved.

The second approach to mitigation involves the restoration of impacted ecosystem structures and functions or the substitution of an unaffected ecosystem to compensate for losses. For example, off-site land acquisition and management of this land to preserve Deciduous Forest (Carolinian Zone) vegetation (including rare species) and associated wildlife may be an appropriate strategy to offset project-induced losses on-site. Such an area would be dedicated to rare species protection and would be designed to reflect pre-development conditions.

6.2 MITIGATION METHODOLOGY

Once potential biological impacts associated with the construction, operations, and post-operations stages of the OWMC facility had ben identified and assessed (Section 5.0), consideration was given to the formulation of a range of appropriate alternative mitigative measures.

For each of the 18 specific biological impacts in Table 17, a range of appropriate mitigative options were reviewed and assessed. These mitigative options generally fall into one of two groups: 1) measures that are normally carried out as components of sound environmental planning, and 2) special actions that would normally not be incorporated into the planning of a project.

Examples of the first type of mitigation would be the encouragement of vegetation growth on portions of the site following landfilling activities and the adoption of sound engineering practices to avoid soil erosion and prevent siltation of downstream watercourses.

Mitigative options which involve special actions are more numerous. These include transplanting of rare species, staged vegetation removal to avoid areas containing rare plant species, and the employment of specific tree felling techniques to minimize the potential for impacts on vegetation growing adjacent to the site.

The effectiveness of each specific mitigative option in terms of preventing, minimizing, rectifying, compensating or enhancing each specific impact was also assessed. This allowed the prediction of the net effect of mitigation on each option. Net effect considers what the expected outcome of mitigation will be (i.e., to what extent the specific structural or functional component of the ecosystem will change following the application of mitigation) and assists in the identification of residual impacts. Residual impacts are addressed in Section 7.1.

For each impact a preferred mitigative option(s) was identified from among all the options presented. In some cases, the application of more than one mitigative option may be the most appropriate strategy to employ, since the cumulative net effect derived from several mitigative actions may be substantially greater than the net effect derived from the application of a single action.

6.3 MITIGATION OPTIONS

The results of the biological impact mitigation analysis are summarized in Table 18. Table 18 identifies the "impact agent" (based on the results of the impact prediction analysis previously reported in Table 17; Section 5.8), describes the nature of the specific impact on structural and/or functional components of the ecosystem ("biological impact factors and indicators", subsequently translated into "impact receptors"), describes a range of appropriate mitigative options, predicts the possible net effect of each mitigative option, and identifies a preferred option(s).

It is important to note that the majority of the biological impacts addressed in Table 18 were previously determined to be of "minor" significance (see Table 17, Section 5.8). For several of these "minor" impacts (e.g., dust deposition on adjacent vegetation, soil moisture loss, noise interference on wildlife, etc.), some of the mitigative options proposed may be less feasible than others, given that high cost and time commitments are involved. Accordingly, the application of mitigation may not be warranted in every case (see Table 18). The degree to which mitigation is appropriate was carefully assessed on a case by case basis, relative to the spatial distribution, frequency, duration, magnitude, potential for occurrence and significance of the specific impact in question. In some instances, the need to apply mitigation may only arise as a result of monitoring biological conditions during the construction, operations and post-operations stages of facility development (e.g., providing wooded "corridors" for deer; see Table 18).

TABLE 18: MITIGATIVE OPTIONS AND THE NET EFFECT OF EACH

IMPACT AGENT	NATURE OF IMPACT	MITIGATION OPTIONS	NET EFFECT OF MITIGATION
Vegetation removal	• displacement of 6 rare plant species as a result of initial site clearing for facility construction and landfilling	* • transplanting and/or propagule collection for planting in suitable habitat elsewhere or in botanical gardens	• depending on success of propagation, net result may be survival of more individuals of rare plants than previously present; may alter structure of habitat receiving transplanted/propagated species; failure of plants to survive in new areas may result in loss of genetic material; natural distribution of species may be altered.
Vegetation removal	• loss of unknown number of hibernating mammals, reptiles, amphibians during initial site clearing of Central Operating Area	• No mitigation possible or required	• loss of unknown number of hibernating mammals, reptiles, amphibians; net effect may be loss of fewer hibernating mammals (e.g.,raccoons, squirrels) since some may leave site of their own volition during site clearing.
Vegetation removal	• removal of vegetation, displacement of wildlife through loss of habitat on-site, along Regional Road 24, Highway 20 and Heaslip Road right-of-ways, and in northwest corner of "Beamer Woodlot".	* • propagation and replanting of vegetation on-site following landfilling (progressive rehabilitation), using native species with high wildlife potential (i.e., species which provide a food source, shelter, nesting habitat) and shallow root systems. * • propagation and planting of native tree-shrub species along road right-of-ways to compensate for vegetation lost during construction of storm sewer/natural gas pipeline, hydro line, Schram Road alignment.	• vegetation on portion of site used for landfilling could be replaced to restore pre-development productivity; if vegetation structure/composition differs from pre-development conditions, a different wildlife community may be attracted. • vegetation removed from site vicinity roadsides could be replaced to restore predevelopment productivity.
Vegetation removal	• reduction in overall efficiency and stability of site ecosystem due to reduction in primary productivity and resource utilization, increase in competition for available resources.	* • replanting of shallowly-rooted vegetation on-site following landfilling	• will result in partial restoration of site productivity; net effect -- reduced productivity, reduced stability compared to pre-development levels; will result in a structurally more simple ecosystem which is more resilient and will recover from perturbations more rapidly, through natural successional processes

* Preferred mitigation option(s)

TABLE 18: (continued)

IMPACT AGENT	NATURE OF IMPACT	MITIGATION OPTIONS	NET EFFECTS OF MITIGATION
Vegetation removal	• removal of vegetation, displacement of wildlife through loss of habitat	*• create through planting or enter into a landowner agreement or acquire and preserve in its natural state, a woodlot of comparable size and structure to the one on-site to compensate for the loss of vegetation/wildlife habitat on-site.	• ideally, gain in or preservation of productivity in the off-site woodlot should equal the loss of productivity on-site; net effect is dependent upon size/structure/species composition of compensatory woodlot; consideration could also be given to creating/acquiring/managing an off-site woodlot larger than the one on-site to enhance the net gain in productivity
		*• clear vegetation on portions of land required for landfilling on an as needed basis (i.e., staged or progressive vegetation removal), thereby retaining two on-site woodlots until latter stages of landfilling operations	• would forestall loss of rare plants, loss of productivity, displacement of wildlife for at least several years following facility construction; would allow more propagule collection, transplanting attempts for rare plants; would give wildlife opportunity to leave site of their own volition.
Construction damage to vegetation	• damage to adjacent vegetation, including 3 rare species (Viburnum, Nyssa, Prunus)	*• employ careful felling techniques to ensure that no trees fall onto adjacent lands	• will reduce potential damage to/loss of adjacent vegetation and preserve rare plants
		• erect plywood hoarding along site edge to protect woodlot adjacent to west-central portion of site	• same as above
		• protect crowns of trees prone to logging damage (e.g.,tie up vulnerable branches)	• same as above
		• prune tree crowns where damaged	• reduced susceptibility to disease and insect damage; health of trees maintained
Drainage alterations to 9C Creek	• shift in structure of a common plant community (mesic to dry) downstream of site	• no mitigation required	• net effect -- shift in structure of plant community from mesic to dry

TABLE 18: (continued)

IMPACT AGENT	NATURE OF IMPACT	MITIGATION OPTIONS	NET EFFECTS OF MITIGATION
Incinerator/Evaporator/ Boiler Stacks	• lights on stacks may act as attractant to nocturnal migratory birds	*• install red-coloured obstruction lights on stacks rather than white floodlights or strobe lights	• will reduce potential for bird kills; net effect -- some birds will still be attracted to lights and may collide with stacks, resulting in death
		*• remove stacks following facility closure/ decommissioning	• will remove obstacle to migratory birds; net effect -- restoration of pre-development conditions
Surface water ponds	• positive impact: provides feeding opportunities for migrant shorebirds on exposed sides and bottom of pond following discharge of water	• none required	• will provide partial restoration of feeding opportunities lost due to removal of aquatic habitat during construction; net effect -- fewer water birds will utilize site for breeding; more water birds will periodically utilize site for feeding/resting
	• negative impacts: - potential for uptake of contamination in "potentially contaminated" surface water pond by wildlife - potential for attracting nuisance wildlife (e.g., gulls, Canada Geese)	*• discourage use of ponds by wildlife through minimizing attractiveness of ponds: - prevent vegetation growth around pond margins by herbicide application, mowing, elimination of shallow littoral areas, lining pond with concrete - dissuade wildlife from utilizing ponds through the use of physical obstacles (e.g..suspend monofilament wires above pond surface)	• net effect -- will eliminate potential for contaminant uptake by fish-eating wildlife, vegetation; - will reduce potential for nuisance wildlife on-site which defecate on structures, feed on grassed areas, and may impair water quality in surface water ponds through defecation
Earth moving	• increased siltation in 9C and Beaver Creeks due to construction activities	*• construct temporary sediment settling ponds at points along Vaughan Road (tributaries of Beaver Creek and 9C Creek); minimize construction activity during periods of high runoff (spring/fall)	• will partially reduce amount of silt entering Beaver and 9C Creeks during construction phase; net effect -- increased siltation of downstream watercourses
	• may result in change to species composition of aquatic invertebrates residing downstream of site	*• immediate seeding of disturbed areas on-site with annual grasses	• same as above
Dust dispersal	• dust deposition on leaves may reduce photosynthetic capacity and diffusion of 3 rare plant species and all adjacent vegetation	*• monitor dust levels to determine if impact occurs and whether it requires mitigation; dust control on-site(e.g., application of calcium chloride and water to bare ground, continuous grading and maintenance of temporary roadway, and unpaved local roads) to reduce impact on humans will have same positive effect on vegetation	• net effect -- potential for calcium chloride contamination of surface water; dust control will restore photosynthetic capacity of adjacent vegetation

TABLE 18: (continued)

IMPACT AGENT	NATURE OF IMPACT	MITIGATION OPTIONS	NET EFFECTS OF MITIGATION
Perimeter ditching	• localized drying trends may extend off-site to west - impact on 3 rare plant species (Viburnum, Nyssa, Prunus) and other vegetation	• alter surface drainage, if required in woodlot adjacent to west-central portion of site through system of ditches	• may compensate for moisture loss due to perimeter ditching and protect rare species; net effect -- loss of soil moisture elsewhere in adjacent woodlot
		* • transplant and propagate rare plant species from adjacent west-central woodlot to similar habitat elsewhere	• net effect of transplanting/propagation may result in more individuals of rare plants, naturalized in suitable habitat elsewhere, than previously present
Erection of fencing	• prevents large mammals (e.g., deer) from using site; removes portion of east-west wildlife corridor between Highway 20 and Vaughan Road.	* • remove fencing following decommissioning of site	• net effect -- restoration of east-west wildlife corridor
		• plant vegetation "corridors" linking wooded areas north of Highway 20, if monitoring indicates such a need	• net effect -- more deer expected to cross Silverdale Road north of Highway 20 between Silverdale Woods and Sucker Creek Woods, increased potential for automobile collisions with deer.
		• erect deer crossing signs at appropriate points along Highway 20, Vaughan Road, and Silverdale Road where deer are expected to cross	• net effect -- will alert vehicle operators to increased likelihood of deer crossings, reduce potential for automobile collisions involving deer
Drainage alterations (perimeter ditching)	• removal of upstream portion of 9C Creek, installation of barrier to upstream movement of aquatic wildlife at Vaughan Road	* • remove barrier at Vaughan Road following decommissioning of site	• will partially restore pre-development flow regime in 9C Creek and provide opportunity for movement of aquatic wildlife upstream of Vaughan Road; net effect -- reduced flow, less wildlife utilization of 9C Creek compared to pre-development conditions
Heaslip Road/Stormwater Sewer	• possible impact on fish due to change in water volume and temperature, dissolved oxygen content of surface water discharge	* • test and (if necessary) treat storm water prior to discharge	• will eliminate contaminants, sediments in storm water prior to discharge; net effect -- water quality may be improved beyond pre-development conditions
		* • monitor temperature, dissolved oxygen content of storm water	• allows more precise prediction of possible impacts on aquatic life at mouth of Welland River
		• install energy dissipators at outfall	• net effect -- will minimize scouring/erosion and enhance oxygen levels

TABLE 18: (continued

IMPACT AGENT	NATURE OF IMPACT	MITIGATION OPTIONS	NET EFFECTS OF MITIGATION
Dust dispersal (continued)		• ensure that bare soil areas are vegetated quickly	• will stabilize soil and reduce potential for dust generation; net effect -- more dust generated than under pre-development conditions
Noise	• possible interference with detection of bird song, frog choruses; impacts expected to be localized (within 200 m of site boundary)	*• monitor noise levels to determine if impact occurs and whether it requires mitigation; construction of berm and sound attenuation devices around perimeter of site to reduce noise impacts on humans will have some positive effect on wildlife	• will help maintain productivity of breeding bird, amphibian community adjacent to site at pre-development levels; net effect -- unchanged

Although many mitigative options were considered, Table 18 only lists those which were deemed to be most practical and most effective in preventing or reducing impacts. In the case of most impacts, the application of some type of mitigation is possible. Although the "Mitigation Options" column in Table 18 does not contain a "do nothing" option (i.e., do not apply mitigation), such an option is nevertheless implied and must, therefore, also be considered for each of the impacts addressed. Since no mitigation is applied, the net effect of the "do nothing" option is therefore unchanged from the original impact, described in the "Nature of Impact" column in Table 18.

Locations where the mitigative options (preferred and otherwise) described in Table 18 could be applied on the preferred site and in the site vicinity are indicated on Figure 17.

Transplanting of rare species is one of the preferred mitigative options described in Table 18. Transplanting is a mitigative technique which may be used in an attempt to save rare plants faced with the threat of removal damage or other forms of indirect impact (e.g., soil moisture changes). Examples of the application of this technique have recently been documented by Watt (1984). However, there is little information available regarding the success or failure of transplanting efforts.

Several differing viewpoints regarding the potential benefits and negative impacts associated with transplanting have recently been expressed by Ontario botanists (Keddy 1983; Suffling and deBoer 1984; Maycock 1985; Webber 1985). The Canadian Botanical Association recently accepted a "Draft Position Paper on Transplantation as a Means of Preservation"

(Anonymous 1986). This position paper is strongly opposed to transplanting and emphasizes that ecosystem preservation is the only way to ensure that a full range of genetic diversity is maintained.

A number of potential negative consequences of transplanting are identified in the Position Paper, and includes the following:

- the rare species no longer interacts with its original physical and biological environment;
- some understanding of the ecology of the species in its natural habitat is lost; and
- natural geographical distributions may be altered.

However, given that rare species growing on the preferred site will be lost as a result of vegetation removal, transplanting is recommended as a mitigative option with the potential to preserve genetic material. This recommendation is made with an understanding that there are potential negative consequences associated with this action. We believe that in this case, the potential benefits of transplanting outweigh the potential negative consequences.

The collection of propagules (i.e., seeds, fruits) of rare plants has also been suggested as a possible means of conserving a genetic pool. This mitigative option could be carried out in place of or in addition to transplanting. The plant material collected could provide valuable scientific information to aid in rare species conservation both in this and other studies. Propagation could be pursued through programs such as the Ontario Rare Woody Plants Program, administered by the University of Guelph Arboretum.

It is recommended that monitoring of mitigation measures be carried out, in order to determine their effectiveness. Future biological impacts which evolve independent of the OWMC facility (e.g., changes in land use practices off-site) may require the implementation of mitigative measures which differ from those which seem appropriate under current conditions (see Table 18).

7.0 RESIDUAL IMPACTS AND CONTINGENCY

7.1 RESIDUAL IMPACTS

Residual impacts are defined as those impacts which remain following the implementation of mitigation or which arise as a direct or indirect result of mitigation. In the context of this study, residual impacts may be considered, to some extent, synonymous with the concept of net effect (introduced in Table 18, Section 6.0). The fundamental difference between the two is that while net effect considers the outcome of each mitigative option on an individual basis, residual impacts are concerned with impacts which remain following the application of a selected set of preferred mitigative options.

Assuming that all the preferred mitigative options identified in Table 18 are implemented, a number of residual impacts are expected to remain. These residual impacts are briefly listed below:

- reduced ecosystem efficiency and stability on-site;
- loss of rare plant species, removal of vegetation and wildlife habitat, displacement of wildlife community on-site;
- reduced flow, increased siltation, less wildlife utilization of 9C and Beaver Creeks;
- change in east-west deer movement corridor from south of Highway 20 to north of Highway 20;

- bird collisions with incinerator, boiler and evaporator stacks;
- reduced photosynthetic capacity of adjacent vegetation due to increased dust levels; and
- reduced reproductive capacity in adjacent wildlife populations due to increased noise levels.

It should be noted that the loss of rare plants, vegetation, and wildlife habitat on-site could be partially offset by the acquisition and preservation of an off-site woodlot of comparable size and structure. Transplanting and the propagation of these rare species could be attempted in suitable habitat which exists elsewhere in the site vicinity.

The remaining residual impacts to the natural environment which have been predicted are all expected to be of minor significance.

Monitoring will measure residual impacts and provide a framework for identifying and reacting to unexpected changes or trends. If monitoring reveals that these residual impacts are greater than initially predicted, the application of additional or alternative mitigative measures may be required. This notion is addressed in the following Section (7.2), as part of the discussion of contingency planning.

7.2 CONTINGENCY

Contingency planning involves identifying the appropriate measures which should be taken to mitigate unexpected impacts, particularly in the event of chance events or accidents which result in the release of contaminants into the environment. A reasonable degree of flexibility is required regarding decisions made during the operations stage (i.e., after project start-up), since such decisions are often directed at altering operational procedures or design.

Spills of untreated special waste during transport, especially into watercourses, should be considered in contingency planning. Such a plan(s) should reflect the sensitivity and significance of the fishery resource in watercourses along the access road through the application of specific measures to minimize the potential impact of spills and clean-up techniques following an accidental occurrence of this kind.

The capacity of the storm water management system which is to be implemented on the site (see M.M. Dillon Limited 1987a) should be designed in such a way that surface drainage can be stored for testing prior to release, in the event that a spill occurs on site. This approach to storm water management has been approved by OWMC and will function to avoid the direct discharge of contaminants to the Welland River via surface water. This will reduce the potential for impact on aquatic life in the Welland River.

OWMC has indicated that the operation and management of the treatment facility will be responsive to findings of routine environmental monitoring or other sources of data which indicate that unforeseen negative impacts on the natural environment have been created. This type of contingency philosophy would ensure that impact monitoring and mitigation are effective, on-going processes and will assist in fulfilling OWMC's goals of minimizing environmental impact and the risk to human health.

8.0 MONITORING

8.1 INTRODUCTION

This section of the report describes monitoring approaches and techniques which could be applied to achieve the following objectives:

- To test impact predictions and provide an assessment of the effects of the proposed OWMC facility on the biological resources of the preferred site and site vicinity study areas;
- To test and evaluate the effectiveness (success and/or failure) of mitigative efforts applied to prevent and/or alleviate biological impacts; and
- To facilitate a recognition of events and/or trends which may result in unexpected natural environment impacts and to enable subsequent reaction to such occurrences (contingency).

8.2 MONITORING APPROACH

For the purposes of this report, the term "biomonitoring" is considered to be a more appropriate synonym for "monitoring" and accordingly is used throughout. Biomonitoring is an analytical tool designed to sample specific parameters of the natural environment through time and space. It can be used to identify both short-term fluctuations and long-term trends, and to distinguish between man-induced perturbations and those which are attributable to natural processes. Biomonitoring has both aquatic and terrestrial applications. By virtue of their sensitivity to pollutants or their specific ecological requirements, certain organisms or biological communities and associations act as indicators of changing environmental conditions.

Biomonitoring is an integral component of any investigation of impacts on the natural environment. Since one of the primary objectives of monitoring is to provide confirmations of predictions which are formulated prior to the initiation of a project, it is essential that baseline studies provide an accurate measurement of those environmental indicators, parameters or variables which have been deemed most appropriate for post-project monitoring. (It is important to note that in the context of biomonitoring, the definition of the term "indicator" is not necessarily synonymous with the definition of "impact indicator" introduced in Section 5.5). The absence of an adequate quantitative description of baseline conditions will seriously jeopardize the integrity of any subsequent monitoring program.

For example, biomonitoring can be one element of an information system for emission management. Results from the time series measurements of specific parameters can be used to make emission management decisions.

There are two basic approaches to biomonitoring, the "bioassay" approach and the "ecological" approach. The bioassay approach involves toxicity testing under controlled, laboratory conditions for lethal, sublethal, and chronic thresholds.

Bioassay studies are designed to identify contaminant sources, areas of impact and zones of recovery, to trace contaminant pathways through the food chain, and to assess the toxicological effects of these impact agents on the receiving organism(s). Bioassays carried out using natural systems in the field (rather than under controlled laboratory conditions) can be called "ecoassays".

The ecological approach to monitoring is intended to monitor changes in population levels, species diversity, and distribution. This approach allows one to ascertain the direct effects of effluents/emissions on nearby plant and animal communities, as well as the less obvious and indirect effects of a particular undertaking. Observed changes in the structure and composition of plant and animal communities are compared against preproject predictions of future change attributable to both natural succession and change brought about by human activities. Unexpected or anomalous changes may be linked to the presence of pollutants, habitat loss or forest fragmentation, alterations in drainage patterns, or the introduction of physical barriers to movement.

The biological indicators/parameters/variables used in this assessment were selected on the basis of the extent to which each meets certain suitability criteria.

From an ecological point-of-view, a biological indicator:

- must occupy a niche that is likely to be affected by the undertaking;
- must have a narrow range of tolerance to impacts;

- must provide the opportunity for regular surveillance; and

- must allow for quantified measurement.

Although not an essential requirement, indicator organisms should occur in some abundance throughout the study area. Particularly for bioassay studies, the indicator organism must be capable of accumulating pollutants in measurable amounts, and demonstrate a change in response to differing degrees of exposure to a specific impact agent.

The choice of biological indicators suggested in Table 19 was influenced by the results of the impact prediction analysis (see Section 5.8). Consideration was given to both the significance of the potentially affected resource and the relative significance of the impact, and to the magnitude, frequency, duration and potential for occurrence of the impact.

Generally speaking, monitoring recommendations are intended to test predictions regarding:

- impacts on significant biological resources;
- impacts of major or moderate significance; and
- impacts of high magnitude, constant frequency, long duration, or with a high/moderate potential for occurrence.

Ecoassay and bioassay monitoring is also necessary to assess the possible effects of stack emissions, surface water runoff, spills of untreated waste on elements of the terrestrial and aquatic ecosystems, and site decommissioning.

As indicated in Section 3.6 (Future Scenarios), changes in land use practices motivated by agricultural crop markets and government environmental management practices may create changes in vegetation and drainage patterns in the site vicinity. These changes will in turn affect fish and wildlife populations.

The biomonitoring program which is designed must be able to accommodate these changes and to yield data which allows effects of the OWMC facility to be separated from those effects caused by land use change. Thus, choice of species to be monitored, location of monitoring stations, and number of "control" stations would all be important in designing the biomonitoring program. Chemical sampling of environmental media and biological tissue would be particularly valuable tools.

8.3 MONITORING OPTIONS

This section of the report contains recommendations concerning various approaches and techniques which should be employed in the monitoring of the biological environment of the preferred site and its surrounding area. These are contained in Table 19. These recommendations are made on the basis of the following:

- OWMC goals and objectives;
- existing biological conditions;
- facility characteristics;
- predicted biological impacts; and
- mitigation options.

Collectively, the four biomonitoring options (grouped according to life form) recommended in Table 19 are designed to monitor environmental change and the nature of potential impacts in significant and sensitive components of the aquatic and terrestrial ecosystems. Both the ecoassay and ecological approach to biomonitoring are represented.

The general purpose and rationale of the four proposed biomonitoring options are also summarized in Table 19. For each option, the indicator organisms and methodologies which would be employed, the frequency and duration of monitoring, and the stage of facility development and the general location in which monitoring should be carried out are provided.

The biomonitoring options described in Table 19 are all preferred options and have been selected from among a wider range of monitoring options which were assessed earlier in Phase 4B.

8.4 SITE DECOMMISSIONING

Decommissioning of the OWMC facility will involve site closure and clean-up as preparation for conversion of the site to other land uses. The closure plan should be addressed in three phases: shutting down the process equipment and storage facilities, dismantling of the facilities, and preparation of the site for "after-use".

Long-term monitoring of the components of the biological environment of the site and site vicinity will be required through the post-operations stage in order to assess the

TABLE 19: BIOMONITORING OPTIONS

LIFE FORM	APPROACH	INDICATOR SPECIES	PURPOSE OF MONITORING PROGRAM	METHOD/TECHNIQUE	LOCATION, STAGE, FREQUENCY, DURATION	RATIONALE FOR SELECTION
Macrobenthos	Ecological	-Ephemeroptera -Chironomidae -Oligochaeta -Plecoptera	-to determine health and integrity of benthic community (species diversity, reproductive success) -to document spatial and temporal changes in benthic community	-sampling of macrobenthic community upstream and downstream of site -identification to genus, species	-Welland River -Sucker Creek -Beaver Creek -9C Creek -Background area -Annually over life of facility	-provides quantitative data re: responses of benthos to changes in water quality, health of community -augments chemical analyses of H_2O -lower trophic level organisms -rapid, accurate, relatively cost-effective
	Bioassay	-Daphnia -Oligochaeta -Chironomidae	-to determine acute and chronic toxicity thresholds of contaminants	-static test (96 hr LC_{50} 48 hr LC_{50})	-laboratory -annually over life of facility	-provides data on effects of toxins on low trophic level organism
Fish	Ecoassay	-Northern Pike -Brown Bullhead -Carp	-to detect presence of and monitor changes in levels of pollutants in fish flesh	-lab analysis of flesh sample	-Welland River -Sucker Creek -Beaver Creek -9C Creek -Background area -annually over life of facility	-data on accumulation of pollutants in upper trophic level organism -potential link to human health
Birds	Ecoassay	-Great Blue Heron (piscivore) -Eastern Kingbird (insectivore) -Barn Swallow (insectivore)	-to detect presence of and to monitor changes in levels of pollutants in eggs of insectivorous and piscivorous birds	-monitor reproductive success (hatching, fledging success, breeding pair density etc.) -chemical analysis of egg shells, embryos	-insectivores: throughout site vicinity -Great Blue Heron colony: west of Hwy 20 -annually (summer) over life of facility	-Great Blue Heron occupies high trophic level -colonial nesting species - represents large sample size -insectivores present throughout area - may feed on insects associated with storm water ponds on site
Vascular Plants	Ecological	-rare species (especially those transplanted/ propagated off-site)	-to determine success and or/failure of transplanting/ propagation -to determine whether health of rare species adjacent to site affected by construction damage, dust, soil moisture loss	-sample species composition, abundance, % cover, importance, health of species	-permanent quadrats established in areas where transplanting/propagation occurs and adjacent to site -annually over life of facility	-allows determination of success of transplanting -provides data on plant community succession, effects of introducing rare species to new area -allows determination of indirect effects of facility on adjacent vegetation
		-representative stands of vegetation in variety of habitat types	-to determine health of vegetation communities in general -to identify changes in species composition, abundance, % cover, importance, etc.	-samplings of vegetation within selected $1\ m^2$ quadrats established in site vicinity during baseline data collection (using Point-Centred Quarter Analysis)	-in selected $1\ m^2$ quadrats throughout site vicinity representative of different habitat types -annually over life of facility	-provides indication of general health of vegetation communities, changes due to natural succession
	Ecoassay	-clonal species	-to detect presence of and to monitor changes in metals which accumulate in plant tissue	-collection of indicator plant species, lab analysis of tissues	-adjacent to site, elsewhere in site vicinity and in background area -annually over life of facility	-provides data on metal levels in lower trophic level, (implications for rest of food chain)

effectiveness of site clean-up. In particular, measurements of contaminant uptake in plants and animals may be included as part of the monitoring requirements for site decommissioning. Detailed analyses of existing soil conditions will help in determining the most appropriate mixtures for supporting specific vegetation communities on the site as part of land reclamation.

9.0 SUPPLEMENTARY INVESTIGATIONS

Since the time of Phase 4B data collection and the subsequent evaluation of these data, it became apparent that additional information would be desirable. Accordingly, OWMC has commissioned GLL to undertake three follow-up studies. These are:

1. Sampling of benthic invertebrates from bottom samples in the Welland River at the site of the storm water outfall and upstream and downstream of the outfall.

2. Sampling of small fish in the Welland River using a bag seine at the site of the storm water outfall and upstream and downstream of the outfall. The result of these two studies will provide input to the monitoring of changes in the water quality of the Welland River, using indicator organisms.

3. A further evaluation of the occurrence of rare plant species in the site vicinity study area. This study will allow a better determination of the significance of the loss of rare plants on-site due to the development of the OWMC facility.

The findings of the above studies will be incorporated into the OWMC Environmental Assessment - Site Assessment Volume (OWMC, 1987b).

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 CONCLUSIONS

Based on the results of the Phase 4B biology study, the following conclusions have been reached:

- The natural vegetation of the preferred site and site vicinity study areas is characterized by a mosaic of woodland, thicket, marsh, old field and recently disturbed fields;
- The vegetation is representative of the Deciduous Forest Region of Ontario and is typical of that which is found on the Haldimand Clay Plain;
- No species listed in the Ontario Endangered Species Act occur on the site;
- Six rare plant species occur on the preferred site and four rare plant species (including two not found on the site) occur in the site vicinity;
- The wildlife communities inhabiting the study areas are representative of typical southern Ontario situations;
- One rare bird species was recorded on the preferred site and one rare mammal species was recorded on both the site and in the site vicinity;
- The fish community inhabiting the Welland River is comprised primarily of coarse fish species typically found in slow moving turbid rivers in the Lake Erie drainage basin;

- The Welland River and Beaver Creek support spawning runs of Northern Pike;

- Three Significant Environmental Units (SEUs) occur in the site vicinity;

- Some tree cutting, hunting and trapping occur on the site and in the site vicinity;

- The majority of impacts associated with construction of the OWMC facility are of minor significance and are expected to be confined to the site and areas immediately adjacent to the site margins;

- Loss of natural vegetation wildlife habitat, removal of a deer corridor, displacement of wildlife, and loss of rare plant species are the primary on-site impacts;

- Off-site impacts are expected to be localized and will affect small areas of vegetation, fish and wildlife habitat adjacent to the site and along facility corridors;

- Few impacts (all of minor significance) are expected to occur during the operations and post-operations stages;

- The application of proposed mitigative measures is expected to reduce the impact of certain construction and operations activities so that residual impacts are of minor significance;

- Facility decommissioning provides the opportunity to remove obstacles to wildlife and to rehabilitate the site to allow replacement of lost habitat;

- Monitoring will allow testing of impact predictions and identify changes or trends in the natural environment (either attributable to natural processes or project-induced pertubations);
- The results of the Phase 4B biology study confirm the basic acceptability of the site for development of the OWMC facility; and
- The results of the impact prediction analysis and recommended mitigation measures, contingency planning, and monitoring programmes fulfill the OWMC objective of minimizing environmental impacts.

10.2 RECOMMENDATIONS

We suggest that OWMC implement the following recommendations:

- design and initiate a monitoring program which makes several years of pre-construction baseline data available, assesses the nature of impacts during facility construction and operation and evaluates the effectiveness of mitigation;
- ensure that stream crossings along access roads are considered in spill contingency planning;
- In selecting plant species and designing of vegetation treatments berms and elsewhere on the site, consideration should be given to re-establishing tree species which have commercial and social values for the local community and

vegetation which has value for wildlife in terms of providing food and shelter;

- obtain biological input in the detailed design of the pumping station and water intake/storm water outfall;
- at the outset of construction, review the feasibility of clearing on an as needed basis, along with progressive rehabilitation; and
- implement the preferred mitigation options outlined in Section 6.0 of this report.

The following table (Table 20) contains a summary of potential biological impacts associated with the OWMC facility, provides an explanation of the significance designation given to each of these impacts, and describes preferred impact mitigation options which could be applied to each. Table 20 represents a synthesis of information which was previously presented in Tables 15 to 18, inclusive and is included in this section of the report in order to summarize and reiterate our conclusions regarding impacts and mitigation.

The left-hand column of this table contains a distillation of those potential biological impacts considered to be most significant and/or most likely to occur and/or of greatest frequency, magnitude and duration. Accordingly, six potential impacts previously identified in Table 18 (i.e., reduction in ecosystem efficiency and stability; removal of upstream portion of 9C Creek; changes in water volume, temperature and dissolved oxygen content of surface water discharged to Welland River; increased siltation of 9C Creek; reduced reproductive capacity

TABLE 20 : SUMMARY OF BIOLOGICAL IMPACTS, SIGNIFICANCE OF IMPACTS, AND IMPACT MITIGATION OPTIONS

IMPACT	SIGNIFICANCE OF IMPACT		IMPACT MITIGATION OPTIONS
* incinerator and evaporator stacks may be obstacles to migratory birds, expecially noctural migrants; certain lighting systems may attract birds	* minor: -	. only small numbers of individuals of large regional bird populations involved . no negative effect on other community components expected . impact felt annually until stacks are removed during decommissioning, but is compensated for by annual recruitment, period of greatest effect is during spring and autumn migration	. install red coloured obstruction lights on stacks rather than white flood lights or strobe lights . remove stacks following facility closure/decommissioning
* constructed surface water ponds may attract aquatic wildlife; a positive impact in providing potential aquatic habitat for aquatic species e.g. fire pond; a negative impact with respect to potential for uptake of contaminants in potentially contaminated storm water ponds	* minor:	. only small numbers of individuals of large regional populations involved . no negative effect on other community components expected . impact during facility lifetime, but negative impact of potentially contaminated storm water is restricted to ice free season and is greatest during and immediately after storm events when these ponds contain water or damp sediment	. discourage use of storm water ponds by wildlife through minimizing attractiveness of ponds to wildlife . minimize plant growth around pond margins by such measures as spraying, mowing, elimination of shallow littoral areas, lining ponds . if ponds are found to attract wildlife despite use of management and design measures noted above, could dissuade use through use of physical obstacles, e.g. suspend monofilament wires above pond if concentrations of contaminants warrant mitigative action
* vegetation removal to realign Schram Road will create a new edge - effects on vegetation: . reduction in vegetated area . change in species composition along new edge	* minor:	. only a small number of individuals of large regional populations involved . minimal negative effect on other community components expected, see comments on wildlife which follow . impact during and following construction phase	. pre-thin edge of woodlot
- effects on wildlife: . change in vegetation composition along edge . reduction in woodlot size . may lead to change in wildlife diversity	* minor:	. only a small number of individuals of large regional populations involved . effects on other community components expected to be minimal . impact during and following construction phase, adjustment in composition of wildlife community as edge vegetation develops	. no mitigation required

TABLE 20 (cont'd) : SUMMARY OF BIOLOGICAL IMPACTS, SIGNIFICANCE OF IMPACTS, AND IMPACT MITIGATION OPTIONS

IMPACT	SIGNIFICANCE OF IMPACT		IMPACT MITIGATION OPTIONS
* fencing around site perimeter would prevent movement of large mammals (eg. deer) from immigrating to/emigrating from site; fencing isolates site from surrounding areas and removes site woodlots from chain of small woodlots south of Highway 20	* minor:	. only a small number of individuals of large regional populations involved . no negative effect on other community components expected . impact throughout facility lifetime	. remove fencing following decommissioning . revegetate site so that it again is part of the E-W corridor or woodlots used by deer . plant vegetation corridor north of Hwy. 20
* removal of on-site vegetation community - loss of 60 ha of dry mesic, mesic, and wet mesic woods, thicket, marsh, old and recently disturbed fields	* minor:	. only a small number of individuals of large regional populations involved . minimal negative effect on other community components expected, see comments on wildlife which follow . negative impact during and following construction phase, once revegetation is begun a positive impact element is introduced	. clear vegetation or portions of site on an as-needed basis . progressive revegetation of landfill cells as they are closed
* loss of individuals of 6 rare plants species and habitat due to site clearing and development: . Pin Oak (6 stems onsite)	* moderate:	. a small number of individuals of the regional population involved, but distribution in Ontario and Canada is limited . no negative effect on other community components expected . impact throughout facility lifetime or at least until re-introduced or re-established on rehabilitated portions of the site	. clear for landfilling on an as-needed basis . collect propagules to perpetuate the gene pool . progressive rehabilitation of completed landfill cells
. Black Gum (2 coppice clumps)	* minor:	. a small number of individuals of the regional population involved . no negative effect on other community components expected . impact throughout facility lifetime or at least until re-introduced or re-established on rehabilitated portions of the site	. clear for landfilling on an as-needed basis . progressive rehabilitation of completed landfill cells
. Wood's Sedge (a few stems)	* moderate:	. the species would be lost at one of two stations where it is known in the Region, but it has wide range in Ontario . no negative effect on other community components expected . impact throughout facility lifetime or at least until re-introduced or re-established on rehabilitated portions of the site	. collect propagules for planting . transplant to suitable habitat
. Small Bedstraw (10 stems)	* moderate:	. the species would be lost at one of 2 stations where it is known in the Region, but it has a wide range in Ontario . no negative effect on other community components expected . impact throughout facility lifetime	. collect propagules for planting . transplant to suitable habitat
. Southern Arrow-wood (numerous bushes)	* minor:	. a small number of individuals of the regional population involved . no negative effect on other community components expected . impact throughout facility lifetime	. none required
. Blunt-leaved Sandwort (number of individuals unkown)	* minor:	. impact on regional population is unkown, but species has a wide range in Ontario . no negative impact on other community components expected	. consider transplanting to suitable habitat

TABLE 20 (cont'd) : SUMMARY OF BIOLOGICAL IMPACTS, SIGNIFICANCE OF IMPACTS, AND IMPACT MITIGATION OPTIONS

IMPACT		SIGNIFICANCE OF IMPACT	IMPACT MITIGATION OPTIONS
* change in moisture regime resulting from construction of perimeter ditch - potential impacts on "common" vegetation species off site e.g. change toward dry woods from dry mesic, change as species adjust or are replaced in response to alteration of moisture regime	* minor:	. only a small number of individuals of large regional populations involved . minimal effect on other community components expected . impact during construction phase and after	. design drainage system so as to minimize change in soil moisture regime off-site
* potential impacts on rare plant species - Black Gum (31 saplings, 75 seedlings)	* minor:	. a small number of individuals of the regional population involved . minimal effect on other community components expected . impact during construction phase and after	
. Canada Plum (1 stem)	* minor:	. only one individual of a regional population involved . minimal effect on other community components expected . impact during construction phase and after	
. Southern Arrow-wood (numerous)	* minor:	. only a small number of individuals of large regional population involved . minimal effect on other community components expected . impact during construction phase and after	
* reduced flow in 9C Creek as a result of drainage alterations - impact on aquatic wildlife downstream	* minor:	. only a small number of individuals of large populations involved . minimal negative effect on other community components expected . impact during site lifetime	. no mitigation required
- impact on hydrophyllic vegetation	* minor:	. only a small number of individuals of large populations involved . minimal negative effect on other community components expected . impact during site lifetime	
* removal of/or damage to roadside hedgerow, thicket and marsh communities along Heaslip Road as a result of storm sewer construction - impacts on vegetation	* minor:	. only a small number of individuals of large populations involved . minimal negative effect on other community components expected . impact during period of construction along Heaslip Road and until last vegetation is replaced	. plant native trees and shrubs to replace those lost during construction along Heaslip Road
- loss of wildlife habitat	* minor:	. only a small number of individuals of large populations involved . minimal negative effect on other community components expected . impact during period of construction along Heaslip Road and until lost habitat is replaced	. planting of trees and shrubs would replace lost wildlife habitat

TABLE 20 (cont'd) : SUMMARY OF BIOLOGICAL IMPACTS, SIGNIFICANCE OF IMPACTS, AND IMPACT MITIGATION OPTIONS

IMPACT	SIGNIFICANCE OF IMPACT	IMPACT MITIGATION OPTIONS
* loss of hibernating mammals, reptiles and amphibians if clearing occurs in late autumn or winter	* minor: . only a small number of individuals of large regional populations involved . minimal negative effect on other community components expected e.g. effects on predators . impact during season of vegetation clearing and earth moving	. no mitigation required
* loss of recruitment mammals, reptiles and amphibians if clearing occurs during breeding/rearing season of mammals	* minor: . only a small number of individuals of large regional populations involved . minimal negative effect on other community components expected e.g. effects on predators . impact during season of vegetation clearing and earth moving	. no mitigation required
* effect of site habitat loss on wildlife following clearing	* minor: . only a small number of individuals of large regional populations involved . minimal negative effect on other community components expected, e.g. effects on predators . impact throughout site lifetime or until rehabilitation of portions of site	. progressive rehabilitation of completed landfill cells
* potential crown and stem damage to site vicinity vegetation as a result of construction activity - "common" species	* minor: . only a small number of individuals of large regional populations involved . minimal negative effect on other community components expected . impact during construction phase and after	. employ careful felling techniques to ensure that no trees fall off site, use plywood hoarding to protect tree trunks
- rare species: Black Gum (31 saplings, 75 seedlings)	* minor: . potentially a small number of individuals of the regional population involved . minimal negative effect on other community components expected . impact during construction phase and after	
- Canada Plum (1 stem)	* minor: . one individual of a regional population involved . minimal negative effect on other community components expected . impact during construction phase and after	
- Southern Arrow-wood (numerous)	* minor: . only a small number of individuals of large regional populations involved . minimal negative effect on other community components expected . impact during construction phase and after	

of wildlife due to increased noise levels; reduced photosynthetic capacity of plants due to dust deposition) have not been included in Table 20.

The middle column contains a more detailed discussion of the significance level assigned to each impact based on the definitions provided in Section 5.6. Where mitigation is recommended, the preferred option(s) for each impact (previously identified in Table 18) are listed in the right-hand column.

These six impacts are all considered to be of minor significance, with a low or, at best, a moderate potential for occurrence. In the event that these impacts were to occur, they are generally expected to be of low frequency and magnitude, of short duration and confined to a small area (Table 17). After consideration of these factors and on the basis of professional judgement, we have concluded that these potential impacts are not significant and do not warrant mitigation.

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13.0 APPENDICES

APPENDIX A

PUBLIC AND AGENCY CONTACTS - PHASE 4B BIOLOGY

APPENDIX A: PUBLIC AND AGENCY CONTACTS - PHASE 4B BIOLOGY

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Mr. R. Curry	Ontario Breeding Bird Atlas Project
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APPENDIX A (cont'd)

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Ms. K. Pryer	National Museum of Natural Sciences
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Mr. & Mrs. Schumacher	Landowners
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APPENDIX B

OWMC PHASE 4B
BIOLOGY FIELD PROTOCOL

APPENDIX B

OWMC PHASE 4B - BIOLOGY FIELD PROTOCOL

TABLE OF CONTENTS

PAGE

B-1 OBJECTIVES AND SCOPE B- 4

B-1.1 INTRODUCTION B- 4
B-1.2 OBJECTIVES B- 5
B-1.3 SCOPE B- 6

B-2 FIELD PROTOCOL - SITE STUDY AREA B- 7

B-2.1 VEGETATION - SITE B- 7
B-2.1.1 OBJECTIVES B- 7
B-2.1.2 FIELD METHODS B- 7
B-2.1.2.1 Point-Centred Quarter Analysis B- 8
B-2.1.2.2 Plant Specimen Collection B-10

B-2.2 WILDLIFE - SITE B-11
B-2.2.1 OBJECTIVES B-11
B-2.2.2 FIELD METHODS B-12
B-2.2.2.1 Winter Bird Communities B-12
B-2.2.2.2 Breeding Bird Communities B-12
B-2.2.2.3 Mammal Communities B-14
B-2.2.2.4 Reptile and Amphibian Communities B-17
B-2.2.2.5 Butterfly Communities B-18
B-2.2.2.6 Resource Use and Impacts B-19

B-2.3 FISHERIES - SITE B-20
B-2.3.1 OBJECTIVES B-20
B-2.3.2 FIELD METHODS B-20
B-2.3.2.1 Pike Spawning B-20
B-2.3.2.2 Aquatic Habitat Assessment B-20

B-3 FIELD PROTOCOL - SITE VICINITY STUDY AREA B-23

B-3.1 VEGETATION - SITE VICINITY B-23
B-3.1.1 OBJECTIVES B-23
B-3.1.2 FIELD METHODS B-24

PAGE

B-3.2 WILDLIFE - SITE VICINITY B-25
B-3.2.1 OBJECTIVES B-25
B-3.2.2 FIELD METHODS B-26
B-3.2.2.1 Winter Bird Communities B-26
B-3.2.2.2 Breeding Bird Communities B-27
B-3.2.2.3 Mammal Communities B-27
B-3.2.2.4 Reptile and Amphibian Communities B-28
B-3.2.2.5 Butterfly Communities B-28
B-3.2.2.6 Resource Use and Impacts B-29

B-3.3 FISHERIES - SITE VICINITY B-29
B-3.3.1 OBJECTIVES B-29
B-3.3.2 FIELD METHODS B-30
B-3.3.2.1 Pike Spawning B-30
B-3.3.2.2 Fish Community Structure and Composition B-30

B-4 APPENDICES B-32

B-4-1 FIELD DATA COLLECTION FORMS - VEGETATION B-33
B-4-2 BOTANICAL SPECIMEN MANAGEMENT B-39
B-4-3 FIELD DATA COLLECTION FORM - WINTER WILDLIFE B-60
B-4-4 FIELD DATA COLLECTION FORM - BREEDING BIRDS B-61
B-4-5 FIELD DATA COLLECTION FORM - MAMMALS B-62
B-4-6 FIELD DATA COLLECTION FORM - REPTILES AND AMPHIBIANS B-63
B-4.7 FIELD DATA COLLECTION FORM - BUTTERFLIES B-64
B-4-8 GILL NET CATCH RECORD B-65
B-4-9 FISHERIES FIELD COLLECTION DATA SHEET B-66
B-4-10 MNR AQUATIC HABITAT INVENTORY SURVEY PROTOCOL B-67

FIGURES

FIGURE B-2-1 - POINT-CENTRED QUARTER METHOD B- 9

FIGURE B-2-2 - MUSEUM SPECIAL SNAP TRAP B-15

FIGURE B-2-3 - METHOD OF SPREADING LEPIDOPTERA B-19

FIGURE B-4-1 - GILL NET B-67

FIGURE B-4-2 - MINNOW TRAP B-69

APPENDIX B
OWMC PHASE 4B - BIOLOGY FIELD PROTOCOL

B-1 OBJECTIVES AND SCOPE

B-1.1 INTRODUCTION

This document is intended to provide a detailed description of the approach and methods which were employed by Gartner Lee Limited (GLL) during the field work component of the OWMC Phase 4B biology study.

The protocol establishes specific data collection methods and allows both the client and external reviewers/technical advisors the opportunity to review and assess GLL's field data collection approach and techniques.

Three major disciplines, vegetation, wildlife and fisheries, comprise the biological component of the Phase 4B study. Although each discipline requires a unique set of methodological procedures, for the sake of convenience protocols for all three have been amalgamated into a single document.

This document is organized according to study area and discipline. Section B-2 contains a description of vegetation, wildlife and fisheries methods/techniques which were applied to on-site field work. Section B-3 is organized in a similar fashion and deals with site vicinity studies. Section B-4 contains appendix material, including examples of data collection forms, excerpts from procedural manuals, and illustrations of equipment. Sections B-5 and B-6 are comprised of a glossary and a list of literature cited, respectively.

B-1.2 OBJECTIVES

The field work component of the Phase 4B biology study addressed the following objectives:

- To verify significant biological features previously identified from literature, unpublished file material, survey questionnaires, and discussions with agency personnel and the public;
- To provide detailed information concerning the existing biological conditions on the preferred site and vicinity.
- To identify those biological resources/features which will potentially receive impacts associated with the construction and operation of the proposed waste treatment and disposal facilities.

Field data collection activities were designed to provide both a qualitative and quantitative description of the existing (baseline) biological conditions of the preferred site and its vicinity, prior to the construction and operation of the waste treatment and disposal facilities. This information was used as background to the impact prediction analysis and aided in the formulation of mitigative measures and an approach to monitoring.

Phase 4B biology field studies utilized current, proven and appropriate methodologies and were carried out in accordance with the provisions of this protocol document.

B-1.3 SCOPE

Botany and wildlife field work was confined to the site, site vicinity and facility service corridor study areas. Some fisheries field work was carried out in a portion of the Welland River, which lies to the south of the site vicinity. The spatial boundaries of these study areas are as described in Section 1.4 of this report and are shown on Figure 4. Within the site and site vicinity study areas, sampling activities were concentrated in the larger woodlots, along several water courses which drain into the Welland River, and within a 500 m radius of the site (see Figures 5 and 6).

Field work activities were scheduled to correspond with specific periods of faunal activity and peak plant growth. The bulk of the field work was carried out during the spring and summer months in order to determine the composition of resident plant and animal communities.

B-2 FIELD PROTOCOL - SITE STUDY AREA

B-2.1 VEGETATION - SITE

B2.1.1 OBJECTIVES

The botanical component of the site study addressed three main objectives. These are:

- To confirm, map and record data regarding the representative and rare plant species previously identifed in Phase 4A;
- To collect and analyse new data which allow a characterization of the vegetation resources of the preferred site; and
- To collect information which will contribute to an assessment of potential impacts on the botanical resources of the site associated with the proposed OWMC facility. OWMC facility.

B-2.1.2 FIELD METHODS

Prior to field studies, airphoto interpretation completed in Phase 4A on a reconnaissance level for the preferred site was refined for "ground truthing".

Botanical field studies were conducted on the site during three separate periods, spring, mid-summer and late summer.

Initial investigations were conducted in mid-May, 1986 to coincide with the flowering of spring ephemerals and to prepare for detailed sampling later in the summer. Preparation involved the confirmation of the homogeneity of the vegetation communities mapped in Phase 4A. The bulk of the botanical data was gathered in mid-summer using the Point-centred Quarter Analysis (Curtis 1959; Mueller-Dombois and Ellenberg 1974).

B-2.1.2.1 Point-centred quarter analysis

Point-centred Quarter Analysis involved sampling trees in four quadrants about a point. The data collected were used to determine species presence, density, dominance, frequency and importance in a homogeneous unit. The results of this analysis provided a quantitative characterization of the vegetation.

The technique was applied to all homogeneous forested units on the site. The spatial boundaries of these units were confirmed during spring (mid-May) observations.

Each homogeneous unit contained up to 30 sample points, depending upon unit size. Points were established in a random fashion, based upon a selected compass route and standard number of paces between samples.

The transect began approximately 15 m in from the forest edge. This minimized the presence of plant species characteristic of open or forest edge environments and insured homogeneity within each sample plot. A distance of approximately 15 m was maintained between each sample point.

At each point, four quadrants were established using a cross made by two lines. One line is the compass direction and the other one is perpendicular to it, as shown in Figure B-2-1.

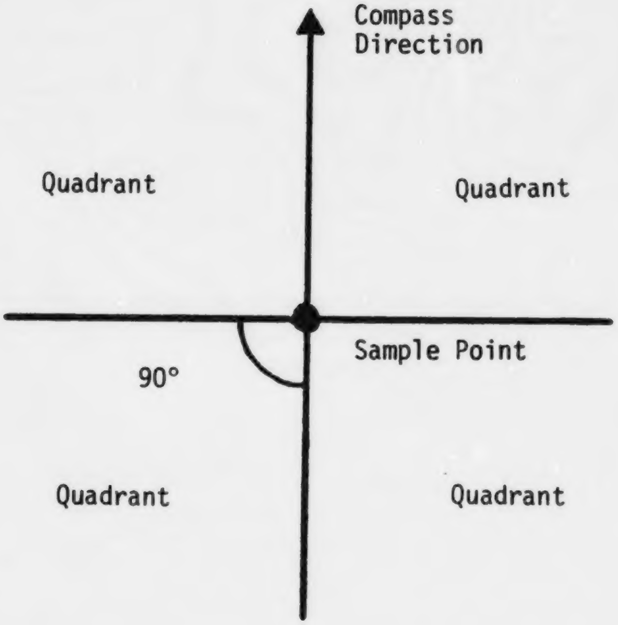

Compass Direction
Quadrant
Quadrant
Sample Point
90°
Quadrant
Quadrant

FIGURE B-2-1: POINT-CENTRED QUARTER ANALYSIS

The nearest tree to the sample point was located in each quadrant using a range finder. Data recorded for each tree included species, distance of the stem mid-point to the sample point, and diameter at breast height.

The nearest sapling in each quadrant was also located. The species and distance from the sample point was recorded.

Definitions of the terms "tree" and "sapling" are included in Appendix M. Examples of the field sheets used to record vegetation data are included in Appendix B-4-1.

At each point, canopy coverage was estimated. At every second point, additional data were recorded. Within the

1 m^2 quadrant centred on the sample point, all other plant species were recorded, including the tree seedlings, shrub, herb, and moss and lichen layers. Definition of these layers are provided in Appendix M. The percent cover of each species was recorded, based upon a visual estimate.

Additional species observed between sample points were recorded on a species list of plants used in the field. Observations were also made of topography, wildlife, ecological features and human and natural impacts.

Point-centred Quarter Analysis was not conducted in forested blocks smaller than 0.5 ha. Qualitative observations were made and a plant species list was compiled.

On non-forested land, sampling consisted of examining the vegetation in randomly selected 1 m^2 quadrants established in homogeneous vegetation units such as marsh, thicket and old field. Ten quadrants in one of each selected non-forested unit were examined for species presence and approximate cover values. Less time was devoted to sampling non-forested lands since they are vegetationally less complex.

A visit was made to the site in late August and early September, 1986 to identify late flowering plants which are less conspicuous earlier in the growing season.

B-2.1.2.2 Plant specimen collection

Attempts were made to identify all species encountered in the field. Where identification was not certain, a specimen was collected, if the population size permitted. If the population size was limited, photography replaced collection. Details of plant collection techniques (Savile 1962) are included in Appendix B-4-2.

Recent and/or accepted works were referred to for taxonomic sequence and nomenclature. These include:

Gleason (1952) - general
Soper and Heimburger (1982) - shrubs
Hosie (1979) - trees
Dore and McNeill (1980) - grasses
Ireland and Cain (1975) - bryophytes
Britton (1984, 1985) - pteridophytes

B-2.2 WILDLIFE - SITE

B-2.2.1 OBJECTIVES

Site specific wildlife investigations are intended to fulfill the following objectives:

- To document the presence of rare species and significant habitats on the preferred site,

- To provide a characterization of the wildlife communities (species composition, distribution and abundance) which utilize the site, especially during critical periods of their life history (e.g., breeding); and

- To collect information which will contribute to an assessment of potential impacts on the wildlife resources of the site associated with the proposed OWMC waste treatment and disposal facilities.

B-2.2.2 FIELD METHODS

A variety of field methods were employed, depending upon the particular life form being studied. This section describes the approach and field techniques which were applied to the following on-site wildlife communities: winter birds, breeding birds, mammals, reptiles and amphibians, and butterflies.

B-2.2.2.1 Winter bird communities

Winter bird populations were sampled on two separate occasions, once in mid-February and again in late February, 1986. The census technique was adapted from the audubon winter bird-population study (Kolb 1965; Robbins 1972). This involved traversing a plot along grid lines spaced at 100 m intervals. The locations of all birds seen or heard were plotted on a field map. Under ideal conditions, the plot should contain homogeneous habitat; for the purposes of this study, however, the plot was considered as the entire preferred site and incorporated several distinct vegetation cover types.

Numbers of individuals of each bird species encountered were recorded on a data collection form (Appendix B-4-3). Sightings were identified with a number which corresponded to a number-location code plotted on the field map.

B-2.2.2.2 Breeding bird communities

Breeding bird populations on site were sampled using the spot-mapping method (Williams 1936; Kendeigh 1944). The spot-mapping method is a sampling procedure which allows a determination of the number of territories of each species in a given study plot, a value from which the relative density of breeding pairs may be derived.

The technique involved sampling the breeding bird population within representative habitat units. Two breeding bird census plots were established, one woodland and one field. Perpendicular transect lines spaced at 50 m intervals were established, forming a grid of 50 x 50 m squares within each plot. All birds seen or heard on each plot were recorded. The location of each observation was marked on a map of the site, overlayed with the grid pattern (Anonymous 1979). Each observation was coded to signify a singing male, non-singing male, female, fledgling or nest. Birds flying overhead were not counted, while those which were observed moving from one plot to another were only counted once and ascribed to the plot from which they originated. Additional information concerning the behaviour of the adult birds, nest materials, height, contents, etc. was recorded. An example of the data collection form used for the breeding bird study is contained in Appendix B-4-4.

Breeding bird populations were censused using this method on six separate occasions from late May to mid-July, 1986. Kendeigh (1944) suggests that a minimum of five replications per breeding season are required to accurately reflect the resident bird community. Prior to this period there is a strong likelihood of encountering migrant individuals and later in the summer territorial defence diminishes in intensity.

Censuses commenced approximately one-half hour after sunrise to coincide with the peak period of avian activity. Repeated encounters with singing male birds in the same location allowed the delineation of approximate territorial boundaries. The number of breeding pairs inhabiting the site and their relative densities within a given area could thus be derived.

The data generated by this census method provided a semi-quantitative description of the breeding bird community inhabiting the preferred site and its structure (dominant species, species richness, and relative density). Mapping the distribution of breeding pairs throughout the site also enabled a qualitative assessment of habitat utilization.

Observations of birds occurring on the site but outside the two census plots were recorded and locations noted on a base map of the site. These data were used to augment the characterization of the resident breeding bird community.

B-2.2.2.3 Mammal communities

Small mammal populations on the site were sampled using a combination of "Museum Special" snap traps (Figure B-2-2) and pitfall traps. These trapping techniques are best suited for the capture of shrews, moles, mice, squirrels and voles.

The census techniques which were used have been adapted from the methodology described by Nagorsen and Peterson (1980).

Three transect lines were established on the site, each sampling a single homogeneous habitat type: upland forest ridges, wet lowland forest slough, and the interface ("edge") between forest and fallow field/pasture.

Each transect contained trapping stations spaced at 10 m intervals. Two traps were deployed at each station. Various combinations of snap traps and pitfall traps were deployed, although the proportion of each depended upon specific conditions at each trapping location (e.g. soil conditions, vegetation cover patterns, and proximity to water).

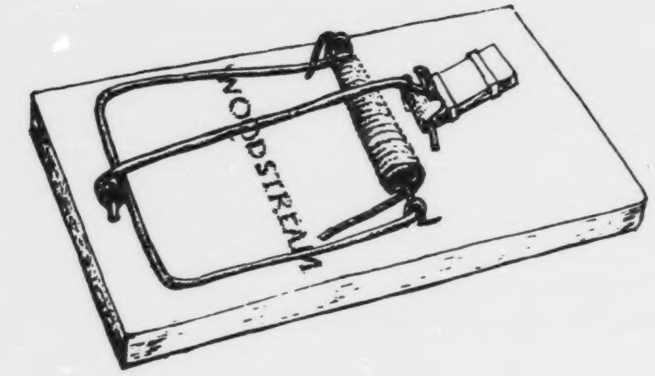


FIGURE B-2-2: MUSEUM SPECIAL SNAP TRAP SHOWN IN THE SET POSITION TRAP SIZE IS 14 CM x 7 CM (5.5 INCHES x 2.7 INCHES). Source: Nagorsen and Peterson (1980).

Snap traps were baited with a combination of rolled oats and peanut butter. Pitfall traps (large 35 cm x 18 cm juice tins) were set flush with the ground. For best results, pitfalls were set adjacent to creeks, margins and slough edges. When not in use pitfall traps contained sticks to allow captured animals to climb out.

Each transect was trapped for three successive nights on two occasions, once in early August and again in early September, 1986. Traps were checked early in the morning following each trap night.

All mammals captured were tagged, sexed, weighed and identified to species or genus in the field in accordance with the procedures outlined by Nagorsen and Peterson (1980). Trap number and location were noted on a field collection form (Appendix B-4-5) and catalogued according to a system used by the Department of Mammalogy, Royal Ontario Museum (Figure 5; Nagorsen and Peterson 1980). Specimens were placed in a freezer bag and stored in a cooler containing dry ice.

Upon completion of the study, all specimens of small mammals were deposited with the Department of Mammalogy, ROM. The ROM verified specimen identifications and prepared study skins/skeletons. This service was provided in exchange for the specimens, which will be permanently housed in the ROM collection.

A "Scientific Collector's Permit" was obtained from the Niagara District office of the Ontario Ministry of Natural Resources and granted permission for the capture of small mammals on the preferred site and in the site vicinity during the period specified. Permission to undertake this trapping program was obtained from the "Animal Care Committee" of OMNR, who reviewed a summary of the proposed methodology.

The results of the small mammal study enabled an estimation of the relative abundance of species in a variety of habitat types based on the number of captures per trap night. It also provided information concerning the composition of the resident small mammal population andhabitat utilization (niches).

The presence of larger mammals on the site was documented through direct observations and evidence (tracks, scats, road kills, utilization of browse, etc.). Species name, number of individuals, location, and other miscellaneous information (habitat, behaviour, etc.) were recorded. Locations of all mammal sightings were indicated on a field map of the site.

To determine the direction and intensity of deer movements on the site, an enumeration of deer tracks was made during two mid-to late February, 1986 site visits. Although track counts cannot provide an accurate estimation of the number of animals using the site, given the low frequency of sampling (Tyson 1959), they may reveal the location of routes typically followed by deer during winter. Ground level investigations were conducted to determine whether the two small woodlots on-site provide a linkage between site vicinity woodlots situated to the east and west of the site.

Winter observations of mammals or signs of mammal activity (tracks, scats, etc.) on-site were recorded and mapped in a similar fashion. These data were augmented by incidental observations of wnter wildlife provided by GLL hydrogeology field staff involved in the drilling program.

The above described studies provided a qualitative assessment of winter habitat use by mammals on the preferred site.

B-2.2.2.4 Reptile and amphibian communities

Frog, toad and salamander occurrence was investigated in the early spring (April, 1986), during the height of their breeding activity. Field investigations were carried out at night. Wet, low-lying areas such as sloughs and ponds were examined to determine whether or not they contained chorusing frogs and toads and breeding amphibious salamanders. At each location examined, estimates of the numbers of individuals of each species involved was made and any other relevant behavioural data recorded. This information was noted on a field data sheet (Appendix B-4-6) and locations were pinpointed on a base map of the site.

Wet sloughs and ponds on-site were examined for larval amphibians in early summer (May to June, 1986). Woodland salamanders, turtles, and snakes were searched for in suitable habitat (e.g., open water, leaf litter, under rotting logs and flat objects in fields) throughout the field season. Shingles and pieces of plywood were laid out throughout field habitat on-site in an attempt to attract snakes. Particular emphasis was placed on determining whether Black Rat Snakes occur on the preferred site.

The reptile and amphibian study provided qualitative information concerning species composition, habitat utilization and the locations of significant areas (hibernacula, breeding ponds, etc.) where concentrations of individuals occur during critical periods of their life cycle.

B-2.2.2.5 Butterfly communities

No formal study of butterfly populations was carried out on the site. Information concerning species composition, habitat preferences, and flying time of adult butterflies were accumulated during the course of the field season. Incidental observations of butterflies were made concurrent with the breeding bird, small mammal, and herpetofaunal surveys. Selected individuals were collected in order to allow verification of species identity.

Specimens were prepared (i.e., pinned, dried, labelled, and mounted) according to the standard specification guidelines for institutional collections (Figure B-2-3; Martin 1977).

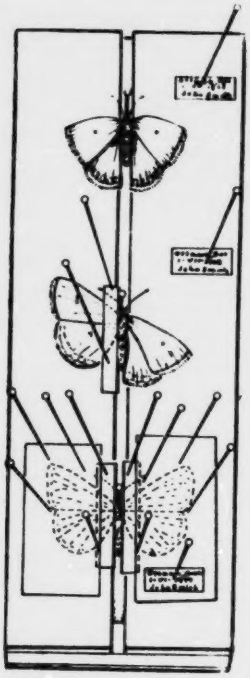


FIGURE B-2-3: METHOD OF PREPARING A BUTTERFLY SPECIMEN
Source: Martin (1977)

Observational data (species, number of individuals, sex, behaviour) were entered onto a field data collection sheet (Appendix B-4-7).

B-2.2.2.6 Resource use and impacts

Observations of wildlife resource use on the site were made throughout the field season. Evidence of such human activities as hunting and trapping were noted on a field data collection form and located on a base map.

Any existing impacts on the wildlife resources of the site (human disturbance, habitat removal, etc.) were also noted.

B-2.3 FISHERIES - SITE

B-2.3.1 OBJECTIVES

The objectives of the on-site fisheries study are:

- To verify the presence or absence of Northern Pike and confirm their spawning condition in an unnamed creek (9C Creek) which flows from the site and drains into the Welland River;
- To assess the significance of this spawning run from a regional and local perspective; and
- To characterize and quantify instream habitat along the unnamed creek.

B-2.3.2 FIELD METHODS

B-2.3.2.1 Pike spawning

The timing of the spring field survey (early April, 1986) was scheduled to coincide with optimal water temperatures for spawning (5° to 7° C) in (9C Creek).

Gill nets were set along the north bank of the Welland River and sampling was concentrated at the mouth of the inflowing tributary (9C Creek) draining from the proposed OWMC site.

Fish sampling results were expressed as catch per unit effort (CUE). Other data collected included species composition, number of fish in spawning condition, and total length and weight of each specimen.

B-2.3.2.2 Aquatic habitat assessment

Aquatic habitat was assessed during the spring high water season and during low summer flows.

Base maps which indicate the type and quantity of habitat found along the creek under high and low flow conditions were developed at a scale of 1:10000.

Stream assessment techniques were patterned after the Ontario Ministry of Natural Resources stream and river inventory program (Dodge *et al*. 1985) and were used to characterize aquatic habitats along 9C Creek,which drains the preferred site. The following characteristics were documented on field base maps and/or in field notes:

Physical characteristics - e.g., bottom substrate conditions, presence of culverts and barriers

Dimensions of stream - e.g., width, depth, cross-sectional area, and velocity.

Critical and important fish habitats such as spawning areas, nursery areas, feeding areas, overwintering areas, and migration routes were identified on a base map. This information contributed to a critical evaluation of potential impacts on the aquatic resources of 9C Creek associated with the proposed OWMC development.

B-3 FIELD PROTOCOL - SITE VICINITY STUDY AREA

B-3.1 VEGETATION - SITE VICINITY

B-3.1.1 OBJECTIVES

The objectives of the botanical studies in the site vicinity study area are similar to those described for the preferred site. These are:

- To confirm, map and record data regarding the representative and rare plants identified in Phase 4A;
- To collect and analyze new data which help to characterize the vegetation resources of the site vicinity; and
- To provide input to an assessment of potential impacts on the vegetation resources of the site vicinity associated with the construction and operation of the proposed OWMC waste treatment and disposal facilities.

The Point-centred Quarter Analysis sampling technique (B-2.1.2) was used to provide a quantitative description of site vicinity vegetation.

Botanical studies in the site vicinity study area were concentrated in an area extending approximately 500 m around the site (Figure 6) since this is where potential impacts associated with the alteration of drainage courses and the creation of facility servicing are likely to be concentrated.

Observations of vegetation were also made throughout the remainder of the site vicinity in a variety of habitat types.

B-3.1.2 FIELD METHODS

Prior to conducting site vicinity field investigations, reconnaissance level airphoto interpretation made during Phase 4A was refined and readied for "ground truthing".

The field methods employed and timing of site vicinity botanical investigations were similar to those used to sample the site. Four field visits were made during mid-May, July, late August and early September, 1986 in conjunction with site field trips. The spring field work included an examination of stand homogeneity in five woodlots within the 500 m band and observations of spring ephemerals within these woodlots. The second trip involved the bulk of the data collection, using the Point-centred Quarter Analysis.

Late summer field work identified late flowering plants in the 500 m band surrounding the preferred site. These plants are less conspicuous earlier in the growing season.

One representative non-forested unit of each habitat type was examined within the 500 m band. Each representative unit was sampled with ten randomly selected 1 m^2 quadrants. Species presence and approximate cover values were noted. Less effort was spent on non-forested lands because of their less complex nature.

Qualitative investigations were also carried out along service facility corridors (e.g., Heaslip Road, Highway 20, Regional Road 24, Silverdale Road and Schram Road) and the northern bank of the Welland River. Specifically, the service alignment running adjacent to Heaslip Road and the 9C Creek was investigated (Figure 6).

Point-centred Quarter sampling was also conducted in representative portions of the Silverdale Woodlot, one of the three Significant Environmental Units (SEUs) in the site vicinity (see Section 3.5.1), to establish baseline vegetation data (Figure 6). The remaining two SEUs were examined qualitatively, with no Point-centred data collected.

Point-centred Quarter sampling within the selected SEU focused on several representative homogeneous blocks. The sample stations studied in the vicinity were mapped and marked with aluminum tags to facilitate future repeat sampling. Field notes indicated the distance and direction of tagged trees from the centre of the sampling point.

B-3.2 WILDLIFE - SITE VICINITY

B-3.2.1 OBJECTIVES

The objectives of the site vicinity wildlife investigations are:

- To document the presence of rare species and significant habitats in the site vicinity;
- To provide a characterization of the wildlife populations which utilize the site vicinity, especially during critical periods of their life history (e.g., breeding); and

- To assess potential impacts of the proposed OWMC waste treatment and disposal facilities on the wildlife resources of the site vicinity.

B-3.2.2 FIELD METHODS

Site vicinity field work was concentrated in the larger woodlots present, three of which were identified as SEUs (see Section 3.5.1) and within a 500 m radius of the site (Figure 6). The larger woodlots and their edges were expected to support the greatest diversity of wildlife species in the site vicinity. Wildlife occupying that portion of the site vicinity which lies within 500 m of the site proper were expected to be most susceptible to potential impacts associated with the proposed waste treatment facility such as: noise, fencing, loss of adjacent on-site habitat, alteration of drainage courses, and the creation of service corridors.

A variety of field methods were employed, depending upon the particular life form being studied. Appendix B-3.2.2 describes the approach and field techniques which were applied to the following on-site wildlife communities: winter birds, breeding birds, mammals, reptiles and amphibians, and butterflies.

B-3.2.2.1 Winter bird communities

Winter bird populations were sampled on two separate occasions, once in mid-February and again in late February, 1986. The census technique used involved driving along all public roads in the site vicinity and recording all birds observed. No private properties were entered. The following data were recorded on field data collection forms: species, number of individuals, station number, and miscellaneous information (behaviour, direction of flight etc.). Locations of stations were noted on a base map of the site vicinity.

B-3.2.2.2 Breeding bird communities

Breeding bird populations in the site vicinity were sampled using the spot-mapping method (Williams 1936; Kendeigh 1944). Details of the spot-mapping method are provided in Appendix B-2.2.2.2. This technique was used to sample Silverdale Woodlot, one of the three large SEU woodlots, a fallow field, and a representative forest habitat situated within 500 m of the site (Figure 6). The methodology employed was identical to that described for censusing breeding bird communities on-site. This approach allowed a direct comparison of breeding bird density and species richness between the site and site vicinity study areas. Each of these three census plots were sampled on six occasions between late May and mid-July, 1986.

B-3.2.2.3 Mammal communities

Small mammal populations in the site vicinity were sampled in a similar fashion to those on the site. The census techniques which were used have been adapted from Nagorsen and Peterson (1980) and are described in detail in Appendix B-2.2.2.3. Snap and pitfall trapping were carried out in two woodland habitats, an upland forest ridge and a lowland forest slough edge. Two transects, one upland and one lowland, were established in a portion of the Silverdale Woods (Figure 6).

Sampling effort in the site vicinity was similar to the sampling effort expended on the site. The same number of traps were deployed in each transect and each station contained two traps. Trapping stations were spaced at 10 m intervals. Timing, frequency and intensity of trapping (i.e., three consecutive nights at a four week interval from early August to early September, 1986) was also similar for both the site and site vicinity.

The presence of larger mammals in the site vicinity was documented through direct observations and evidence (tracks, scats, browse, etc.). Species name, number of individuals, location, and other miscellaneous information (habitat, behaviour, etc.) were recorded. Locations of mammal sightings were indicated on a field map of the site vicinity.

White-tailed Deer movements in the site vicinity were investigated through an enumeration of deer tracks. This was carried out during two visits to the site vicinity in February, 1986. Public roads in the site vicinity were driven/walked to determine points where deer cross these roads in winter. This information assisted in determining the location of deer "corridors" and the use of small wooded "islands" in the site vicinity as stepping stones between larger tracts of forested land. The results of these ground level investigations were augmented by aerial deer census data collected during three of the past five winters by the OMNR.

B-3.2.2.4 Reptile and amphibian communities

The methodology which was employed to sample site vicinity amphibians and reptiles was identical to that described in Appendix B-2.2.2.4. Sampling effort, however, was concentrated along site vicinity roadsides in the spring, to detect the presence of chorusing frogs and toads. Snakes, salamanders, and turtles were searched for in suitable areas of pond and woodland habitat.

B-3.2.2.5 Butterfly communities

The approach and methodology which were used to sample butterflies in the site vicinity were identical to those described in Appendix B-2.2.2.5.

B-3.2.2.6 Resource use and impacts

Observations of wildlife resource use in the site vicinity were made throughout the field season. Evidence of such human activities as hunting and trapping were described, documented with photographs, and located on a base map.

Any existing impacts on the wildlife resources of the site vicinity (such as human disturbance and habitat removal, etc.) were also noted during the field season and documented in the manner described above.

B-3.3 FISHERIES - SITE VICINITY

B3.3.1 OBJECTIVES

The objectives of the site vicinity fisheries study are:

- To characterize and quantify instream hbitat (particularly critical life history habitt) along the Welland River and at the mouth of Beaver Creek;
- To characterize the structure and composition of the fish communities inhabiting these watercourses and their utilization of aquatic habitats;
- To document the presence of rare fish species; and
- To assess the potential impacts of the proposed OWMC waste treatment and disposal facilities on the fisheries resources of downstream watercourses.

B-3.3.2 FIELD METHODS

B-3.3.2.1 Pike spawning

The use of the site vicinity watercourses as fish spawning runs were assessed during the spring.

The approach and methodology which were employed are identical to those proposed for the investigation of fish spawning in 9C Creek and are described in detail in Appendix B-2.3.2.1.

B-3.3.2.2 Fish community structure and composition

A summer fish sampling program was carried out, with mose of the effort concentrated in the Welland River at the mouth of Beaver Creek and 9C Creek. Although some of the upstream portions of these creeks were dry throughout much of the summer, minnow traps were used to sample for small fish species and young-of-the-year.

Results of the gill netting conducted in the Welland River were reported as catch per unit effort (CUE), species percent composition, and relative abundance. Seasonal variations in these data were compared.

All fish captured in gill nets were identified to species, examined to determine reproductive condition, measured and weighed in the field. The physical characteristics of each sampling station were also described. These data were recorded on two field sheets, examples of which are contained in Appendices B-4-8 and B-4-9. Cross-sections of the Welland River were measured at several locations, from the mouth of 9C Creek upstream to the mouth of Beaver Creek.

Detailed descriptions of fish sampling methods, the equipment employed and procedures followed are provided in Appendix B-4-10. This information has been adapted (in whole or in part) from the OMNR's Manual of Aquatic Habitat Inventory Surveys (Dodge _et_ _al_. 1985).

B-4 APPENDICES

APPENDIX B-4-1

VEGETATION DATA COLLECTION FORMS

B-33

POINT RECORD TREES - BOTANY FIELD OBSERVATION SHEET
OWMC 85-BB-2, 85-BB-3 DATE____________

STAND NUMBER____________ OBSERVER____________

Gartne
Lee
Associa
Limited

STATION NO.	1	2	3	4	5	6	7	8	9	10
Acer nigrum										
Acer rubrum										
Acer saccharinum										
Acer saccharum										
Betula lutea										
Carpinus carol.										
Carya cordiformis										
Carya ovata										
Crataegus spp.										
Fagus grandifolia										
Fraxinus amer.										
Juglans cinerea										
Ostrya virginiana										
Pinus strobus										
Populus tremuloides										
Prunus serotina										
Prunus virginiana										
Quercus alba										
Quercus bicolor										
Quercus rubra										
Sassafras albidum										
Tilia americana										
Ulmus americana										
Ulmus rubra										

(Adapted from University of Toronto Field Sheet)

Page______ of ______

Gartner Lee Associates Limited

PRESENCE LIST - BOTANY FIELD OBSERVATION SHEET
OWMC 85 BB2, 85 BB3

STAND NUMBER __________

OBSERVER __________

DATE __________

TREES

Acer negundo
Acer nigrum
Acer rubrum
Acer saccharinum
Acer saccharum
Amelanchier spp.
Betula lutea
Betula papyrifera
Carpinus caroliniana
Carya cordiformis
Carya ovata
Castanea dentata
Cornus florida
Crataegus spp.
Fagus grandifolia
Fraxinus americana
Fraxinus nigra
Fraxinus pennsylvanica
Juglans cinerea
Juglans nigra
Liriodendron tulipifera
Nyssa sylvatica
Ostrya virginiana
Pinus strobus
Populus deltoides
Populus grandidentata
Populus tremuloides
Prunus pensylvanica
Prunus serotina
Prunus virginiana
Quercus alba
Quercus bicolor
Quercus macrocarpa
Quercus palustris
Quercus rubra
Quercus velutina
Sassafras albidum
Tilia americana
Tsuga canadensis
Ulmus americana
Ulmus rubra
Ulmus thomasi

SHRUBS AND HERBS

Acer spicatum
Achillea millefolium
Actaea pachypoda
Actaea rubra
Adiantum pedatum
Agrimonia gryposepala
Allium tricoccum
Amphicarpa bracteata
Anemone cylindrica
Anemone quinquefolia
Anemonella thalictroides
Antennaria sp.
Apocynum androsaemifolium
Aquilegia canadensis
Aralia nudicaulis
Aralia racemosa
Arenaria lateriflora
Arisaema atrorubens
Asarum candense
Aster acuminatus
Aster ciliolatus
Aster lateriflorus
Aster macrophyllus
Athyrium filix-femina
Botrychium multifidum
Botrychium virginianum
Brachyelytrum erectum
Calamagrostis canadensis
Camptosorus rhizophyllus
Cardamine bulbosa
Carex albursina
Carex brunnescens
Carex deweyana
Carex gracillima
Carex intumescens
Carex laxiculmis
Carex laxiflora
Carex pedunculata
Carex pensylvanica
Carex rosea
Carex tenera
Caulophyllum thalictroides
Ceanothus ovatus
Celastrus scandens
Chelidonium majus
Chelone glabra
Cicuta maculata
Cinna arundinacea
Circaea alpina
Ciraea quadrisulcata
Cirsium sp.
Claytonia virginica
Clintonia borealis
Collinsonia canadensis
Comandra umbellata
Conopholis americana
Corallorhiza maculata
Cornus alternifolia
Cornus florida
Cornus racemosa
Cornus rugosa
Corylus americana
Cryptotaenia canadensis
Cystopteris bulbifera
Cystopteris fragilis
Danthonia spicata
Dentaria diphylla
Dentaria laciniata
Desmodium acuminatum
Dianthus barbatus
Dicentra canadensis
Dicentra cucullaria
Diervilla lonicera
Dioscorea villosa
Dirca palustris
Disporum lanuginosum
Dryopteris marginalis
Dryopteris noveboracensis
Dryopteris spinulosa
Elymus virginicus
Epifagus virginiana
Epipactis helleborine
Erigeron philadelphicus
Erythronium americanum
Euonymus obovatus
Festuca obtusa
Floerkea proserpinacoides
Fragaria virginiana
Galium aparine
Galium boreale
Galium lanceolatum
Galium triflorum
Gaultheria procumbens
Geranium maculatum
Geranium robertianum
Geum canadense
Glyceria striata
Hamamelis virginiana
Helianthus sp.
Hepatica acutiloba
Hepatica americana
Hieracium aurantiacum
Hydrophyllum canadense
Hydrophyllum virginianum
Hystrix patula
Impatiens capensis
Impatiens pallida
Juniperus communis
Laportea canadensis
Leersia virginica
Lilium philadelphicum
Lindera benzoin
Lobelia inflata
Lonicera canadensis

Lonicera dioica
Lonicera hirsuta
Luzula acuminata
Lycopus americanus
Lycopus uniflorus
Lysimachia ciliata
Lysimachia quadrifolia
Maianthemum canadense
Medeola virginiana
Melampyrum lineare
Menispermum canadense
Mitchella repens
Mitella diphylla
Monotropa uniflora
Onoclea sensibilis
Oryzopsis asperifolia
Osmorhiza claytoni
Osmunda cinamomea
Osmunda claytoniana
Oxalis europaea
Panax trifolius
Parthenocissus inserta
Parthenocissus quinquefolia
Pedicularis canadensis
Phlox divaricata
Phryma leptostachya
Pilea pumila
Poa compressa
Poa pratensis
Podophyllum peltatum
Polygala senega
Polygonatum biflorum
Polygonatum pubescens
Polystichum acrostichoides
Potentilla simplex
Prenanthes alba
Prenanthes trifoliata
Prunella vulgaris
Pteridium aquilinum
Pyrola elliptica
Quercus prinoides
Ranunculus abortivus
Ranunculus recurvatus
Rhamnus frangula
Rhus radicans
Ribes cynosbati
Ribes triste
Rosa sp.
Rubus (blackberry)
Rubus idaeus
Rubus odoratus
Rubus pubescens
Sambucus canadensis
Sambucus pubens
Sanguinaria canadensis
Sanicula gregaria
Saxifraga virginensis
Scutellaria epilobiifolia
Scutellaria lateriflora
Smilacina racemosa
Smilacina stellata
Smilax ecirrhata
Smilax herbacea
Smilax hispida
Solanum dulcamara
Solidago caesia
Solidago flexicaulis
Sphenopholis intermedia
Spiraea alba
Stellaria sp.
Streptopus roseus
Taraxacum officinalis
Thalictrum dioicum
Tiarella cordifolia
Tovara virginiana
Trientalis borealis
Trillium erectum
Trillium grandiflorum
Triosteum aurantiacum
Uvularia grandiflora
Uvularia sessilifolia
Vaccinium angustifolium
Vaccinium corymbosum
Vaccinium myrtilloides
Veronica officinalis
Viburnum acerifolium
Viburnum cassinoides
Viburnum rafinesquianum
Viola canadensis
Viola conspersa
Viola cucullata
Viola pubescens
Vitis riparia
Waldsteinia fragarioides
Xanthoxylum americanum
Zizia aurea

Additional Species

(Adapted from University of Toronto field sheet)

page ___ of ___

TREE DATA SUMMARY - BOTANY FIELD SUMMARY SHEET

Gartner Lee Associates Limited

OWMC 85-BB-2, 85-BB-3

ANALYZED BY____________________

CHECKED BY____________________ STATION NUMBER__________

TREE	# PTS	# TRS	DOM. CLASSES			TOT. DOM.	# SAP	D. % SAP	F. % SOL.	F. % TRS.	% SUM F.TR.	D. % TRS.	DOM% TRS.	DFD INDEX	
			-80	-320	321										
Acer nigrum															
Acer rubrum															
A. saccharin.															
A. saccharum															
Betula lutea															
Carpinus carol.															
Carya cordif.															
Carya ovata															
Crataegus spp.															
Fagus grandif.															
Fraxinus amer.															
Juglans cinerea															
Ostrya virgin.															
Pinus strobus															
Populus tremul.															
Prunus serotina															
Prunus virgin.															
Quercus alba															
Quercus bicolor															
Quercus rubra															
Sassafras al.															
Tilia americana															
Ulmus amer.															
Ulmus rubra															

AVE. DIST. BTW'N TREES: AVE B. A.: # TREES/ACRE: DOM./ACRE:

(Adapted from University of Toronto Field Sheet) Page_____ of _____

STAND RECORD - BOTANY FIELD OBSERVATION SHEET
OWMC 85-BB-2, 85-BB-3 DATE____________
STAND NUMBER____________ OBSERVER____________

Gartner
Lee
Associates
Limited

Name: **Locality:**
County: **T:** **C:** **L:**
Date: **Observers:**
Size of Stand: **Size of Area Sampled:**
Forest Type: **Soil Type:**
Topography: **Slope:** **Directions**

Condition of Stand:

Open Grown Trees: **% Canopy:**
Stumps:

1.	4.	7.	10.
2.	5.	8.	11.
3.	6.	9.	12.

Soil Data:

	pH	N	P	K	Ca	Mg	Org. Mat.	Colloids	W.H.C.		
Ao											
A1											
A2											
B											

	DEPTH	CHARACTERISTICS (Color, Texture, Structure, etc.)
A_o		
A_1		
A_2		
B		

Parent Material:

Map:

(Adapted from University of Toronto Field Sheet)

Page______ of ______

APPENDIX B-4-2 - BOTANICAL SPECIMEN MANAGEMENT

Publication 1113 March 1962

COLLECTION AND CARE
OF
BOTANICAL SPECIMENS

D.B.O. Savile
Plant Research Institute
Central Experimental Farm
Ottawa, Ontario

RESEARCH BRANCH
CANADA DEPARTMENT OF AGRICULTURE

Although many of the methods described are applicable to the tropics, this manual does not deal with problems peculiar to tropical regions. It is based mainly on experience gained in temperate, arctic and alpine Canada and is most useful to collectors in countries with a somewhat similar climatic range.

Considerable emphasis is placed on arctic and alpine collecting. This is a field that has until recently been neglected, both in quality and in quantity of specimens, and is only now coming fully into its own. In his training as a student in the temperate zone the average botanical collector never encounters, or even learns of, some of the problems that will beset him on his first trip up a mountain or into the north. Arctic collecting offers a variety of problems that, if not solved promptly, may be serious and unpleasant in a region where the field season is very short and travel costs are high. Both the comparative inaccessibility and the small but highly dispersed flora of the arctic make it desirable that arctic collectors be prepared to collect all groups of plants with the smallest possible loss of time. Varied experience in several parts of the Canadian arctic and in the alplands of the northern Cordillera has given our field parties the opportunity to overcome many of the difficulties.

This book is based on the experience and suggestions of various staff members and is accordingly to be regarded as a product of the Institute. I must explicitly acknowledge the help of Mr. W. J. Cody in drafting much of the material on herbarium methods found in Chapter 1, and of Dr. W. G. Dore, who has long been accumulating information on field and herbarium techniques. For the last three chapters it is a pleasure to acknowledge the advice in the field or through correspondence of Drs. Howard A. Crum, Herman Persson, William C. Steere, William Randolph Taylor, and William A. Weber. Much use has been made of the instruction booklets for naturalists in the armed forces, written by Dr. Steere and Dr. Taylor and published by the University of Michigan. Some use has also been made of the revised edition of Dr. Taylor's *Marine Algae of the Northeastern Coast of North America*.

CHAPTER 1

VASCULAR PLANTS

Collecting

The Specimen

Making satisfactory specimens of flowering plants, ferns and fern allies requires ample and well-pressed material labeled with all pertinent information.

In collecting small herbaceous plants, take the whole plant, including the root system; the type of root system or the presence and shape of bulbs or tubers may be diagnostic. Fold tall plants neatly to a length slightly less than the width of a newspaper. They will then fit on a standard sheet of herbarium mounting paper (16½×11½ inches).

Large and bulky plants must be trimmed in various ways. Split the lower part of a very thick stem, or a fleshy crown. This treatment hastens drying and, by enabling the elements of the press to come together more closely, prevents the leaves from wrinkling. Occasionally remove some leaves; otherwise they will lie several deep on the sheet. Do not try to conceal the removal of leaves, but cut them off close to the stems, leaving short stubs that will enable an examining botanist to see the number and positions of the leaves. Do not remove too many leaves from one part of the plant, for the leaves may vary in form from the bottom to the top of the stem. Leave all the leaves on if you can; spread them out or bend the petioles of some of them to prevent overlapping and crowding.

Tall plants with large leaves, such as *Heracleum maximum*, are difficult to prepare. You may have to make a two-sheet specimen, with the inflorescence and a small upper leaf on one sheet and a middle or lower leaf and a short section of split stem on the second sheet. Then include in accompanying notes data not evident from the specimen, such as plant height, size of largest leaf and thickness of stem at base.

If the plants are only about 6 inches high and have a single flowering stem, take six or eight of them for mounting on one sheet. Select plants that show the normal range in variable characters such as height. When collecting minute plants, take a dozen or more, as many of these bear only one or a few flowers or fruits. If plants are to be sent away for identification take enough for at least two sheets, one for the collector and one for the determiner.

Specimens of trees and shrubs should include vegetative shoots, flowering or fruiting shoots and patches of bark, cut to fit the sheet. Make notes on estimated height, trunk diameter at breast height (d.b.h.) and habit (tree or shrub, spreading or columnar, branches erect or pendulous, or similar information).

It takes very little time and is helpful to include extra flowers or fruit with the specimens. They are eventually put into packets, and can be used for dissection without the mounted specimen being mutilated.

With various plants, fruiting material is more important than flowering material. This is particularly true of the Cruciferae (mustard family), Onagraceae (evening primrose family), Umbelliferae (carrot family), Juncaceae (rushes), Cyperaceae (sedges), and (young fruit only) the genus *Salix* (willows); but this recommendation applies in different degrees to a variety of plants. Even fruits that are not important to the taxonomist may be necessary for a proper understanding of the natural history of a plant. Most herbaria contain inadequate fruiting material of many plants. It is thus generally advisable to collect both flowering and fruiting material whenever possible. Sometimes flowers and fruit occur at the same time on the same plant; sometimes flowers may be found in a shady spot or moist depression after most of the colony has gone to fruit. With the complex genus *Crataegus*, in which flowers and fruit do not occur simultaneously, you should, if possible, tag the tree from which flowers are taken and return later for the fruits. Collect grasses after they have started to flower, when the anthers may be seen hanging from the florets. They may be taken somewhat later, after the anthers have shriveled; but if they are taken fully ripe the seeds usually shatter out badly and a poor specimen results. Sedges (Cyperaceae) should be taken in nearly full fruit; some species that shed their fruits readily when fully ripe must be collected before the heads break up when pressed between the fingers.

Remove as much of the soil as possible when you dig the plants, to avoid disfiguring them. It is often impossible to remove soil particles from plants that have viscid hairs; and sand grains may bruise and blacken delicate leaves. The more soil you remove at the time of digging, the more thoroughly you can clean the plants before putting them into the press. A difficult problem is presented by glandular-viscid beach plants, such as *Glehnia littoralis*, which are usually encrusted with sand when you collect them. Such plants are always robust, however, and may be washed in the sea or in a pool or stream without damage. By soaking them for a few minutes and wiping the submerged leaves, you may remove most of the sand. The roots of plants growing in clay or bog soil must generally be washed in water. The dense tangle of roots of some rhizomatous grasses and sedges often presents a difficult problem. You may often save time by standing some clumps in water while working on others. If you are near a fast brook or a beach with breaking waves, weigh down the plants with stones so that the roots are in the moving water, but the tops out of it, and leave them while collecting other plants.

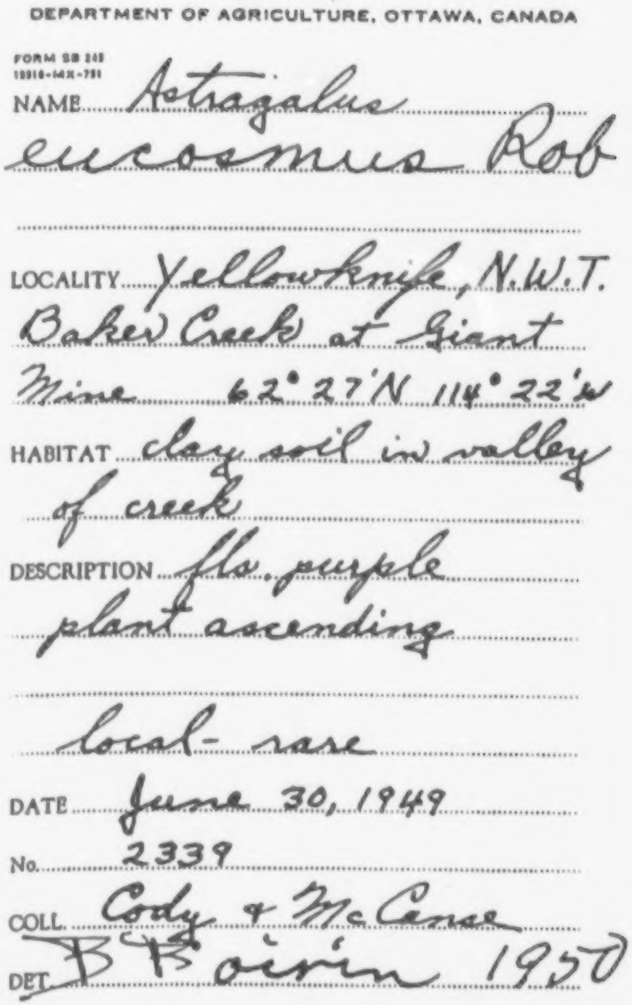
Some arctic and alpine plants have several years' accumulation of dried leaves at their bases. Do not remove all of these leaves, because they are sometimes an aid in identification (for example, in *Potentilla*). Similarly, fibrous remains of old leaves (for example, in some *Carex* or Umbelliferae) should not be cleaned off completely.

Field Notes

Make notes in the field on any items that may not be obvious from the dried specimen. It is from this information that the final label must be prepared (Figure 2). Include colors, especially of flowers, which often change in drying; scent; records of blossom-visiting insects; height and habit of plants too large to be included intact in the specimen; associated vegetation, such as type of forest or grassland; degree of shade; approximate soil type and soil moisture; elevation, at least in mountain country; exposure; slope; locality; date; collector's name; and collection number. All collectors should regularly use collection numbers. A simple numerical sequence that goes on from year to year is much better than a complex system that starts anew each year. Apart from other uses, the collection number greatly simplifies the citation of specimens by students who use the specimens in later years.

If the stature or habit varies greatly with soil moisture, shade or any other factor, record the extremes of variation. Elevation is important in mountainous country, and the elevation range is equally important; but the range of elevation may differ markedly on the two sides of a mountain or ridge. Exposure is important, especially in mountainous areas. A southern exposure generally speeds flowering in the north temperature zone. In the arctic, however, exposure is often more important for its relationship to the direction of the winter wind, and the snow that accumulates on the down-wind slope of a steep hill, bank or cliff and covers the ground for most of the summer. Near a seacoast the seaward slope is generally much wetter than the landward one. The insect relationships of many genera—even of some entire families—are still almost unknown. It is therefore important to record as precisely as possible the type of insect visitor whenever one is seen at a rare plant or one that grows in inaccessible places.

The method of recording data depends on circumstances and personal preference. A simple method is to use a field label, an example of which is shown in Figure 1. This is



DEPARTMENT OF AGRICULTURE, OTTAWA, CANADA

FORM SB 241
10918-MX-751

NAME Astragalus
eucosmus Rob

LOCALITY Yellowknife, N.W.T.
Baker Creek at Giant
Mine 62° 27'N 114° 22'W

HABITAT clay soil in valley
of creek

DESCRIPTION flo. purple
plant ascending

local- rare

DATE June 30, 1949

No. 2339

COLL. Cody & McCanse

DET. B Boivin 1950

Figure 1.—Example of completed field label. The printed form is generally filled out in pencil at the time of collection. The name of the plant is added later.

table taped to the case. Any aircraft instrument shop will be able to do the calibration; or, if necessary, it can be done in the laboratory under a bell jar, with the aid of a vacuum line and a sensitive manometer. The method is described in aircraft instrument manuals.

There is little need to list here the general run of non-botanical equipment for field and camp; but one item may be mentioned. If you expect to spend much time in a tent with next to no furniture, there is a problem involved in keeping books, notebooks and miscellaneous small items from becoming damp, dirty or dispersed. A large brief-case of the type that stands up and opens like a gladstone bag is excellent for the purpose. For brief trips, when you are traveling light, such items as you need can be put in a plastic bag.

The Field Press

Of the many means that have been used to carry plants until they can be transferred to the press, there can be little doubt that the best, under nearly all circumstances, is what has come to be called the field press. Actually, it is a satchel or portfolio rather than a press, but the name is now established. The field press seems to have been predominantly a North American development. Various institutions have evolved serviceable designs from crude early models. The one described below, and illustrated in Figures 4 and 5, is the joint development of several members of the Institute. In its present form it has proved satisfactory under a variety of arctic, alpine and lowland conditions.

Construction.—Basically the field press is a satchel of lightweight waterproof fabric. Until recently we used waterproofed canvas, but we have now changed to a rubberized nylon fabric, which, although initially more expensive, is very light and almost indestructible. The dimensions are based on the corrugated cardboard ventilators, 18×12 inches, used with the plant press, described later in this chapter. A ventilator is slid into a pocket at each end of the field press to stiffen it. These pockets also serve to hold small pieces of equipment, such as labels, paper or plastic bags, maps, and often the collector's lunch if he is out on foot for the whole day. It will be seen from the illustration that there is a flap at one side which covers the top of the closed press, reducing drying of the specimens and protecting the paper and cardboard from rain. At each end of each half of the press there are other flaps that are folded inward to reduce drying and prevent the loss of small specimens. These flaps hook together, being closed with a strong but quick-releasing hook-and-eye fastener that may be made or bought locally. They are mounted on light webbing straps with a sliding length adjuster. The webbing is attached to a loop of shock cord (rubber strands with a woven cotton covering), which slides through a casing in each side of the flap. The shock cord is securely sewn into the base of the flap, by hand sewing with heavy thread through both rubber and canvas, with the

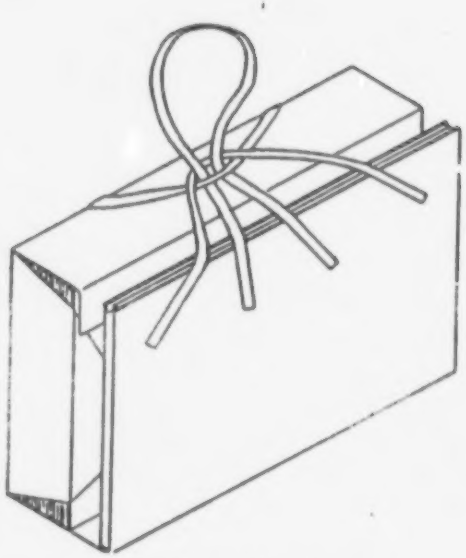


Figure 4.—Field press in use.

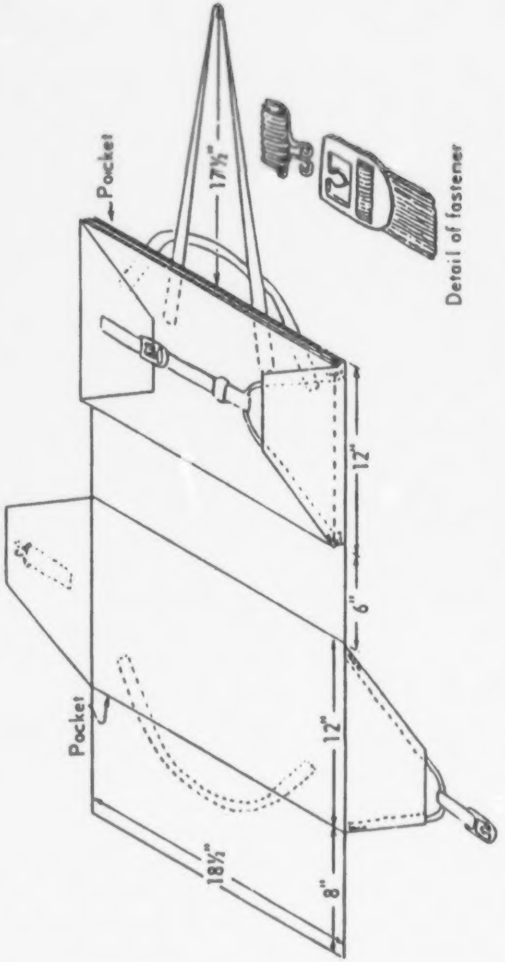


Figure 5.—Field press opened to show construction. For details see text.

aid of a sailor's palm. Attempts to anchor the shock cord by pinching it with machine stitching have always proved ineffective, but stitching repeatedly through the cord anchors it for the life of the field ptess. The shock cord must be anchored at the base of the flap to allow adequate extensibility.

Use.—Place a supply of cut and folded newsprint in the side of the press without the covering flap. The paper is held in place with a cardboard ventilator and the tension of the shock cord. As specimens are collected, lay sheets of paper in the other side with the hinge towards the center of the field press. Place specimens as neatly as possible on the sheet and fold the sheet over them. Add a cardboard and hook the flaps together over it. Start with the webbing straps adjusted so that the specimens are held snugly. As the bulk of the specimens increases during the day it may be necessary to slack off the straps. If this side of the press becomes very heavily loaded, start inserting specimens in the opposite side with the supply of paper, which will now be greatly diminished.

On hot, dry days spread a few handfuls of grass or other foliage over the bottom of the press before the first specimens are inserted, otherwise wilting will soon occur. Under very arid conditions it is advisable to start with damp paper. If the paper is not sufficiently damp from the previous day's work, sprinkle a little water here and there between the sheets. There are a few plants, such as *Melampyrum lineare*, that are very hard to collect without the leaves wilting and crumpling. If possible take a press to the colony and press the plants directly. If this procedure is impractical, lay the plants in the field press in soaking wet paper.

Some collectors prefer to lay out their plants for the press directly in the field press, and to transfer them to the press in the same paper. Others use fresh paper in the press and do their final laying out after returning from the field. Whichever method is adopted depends partly on personal preference but largely on field conditions. If one is working in very hot weather, when rapid wilting is to be expected, there is an advantage in pressing the plants without rehandling; for limp leaves and petals may easily be damaged. When this method is used it is important that the tension on the specimens should be strong, to prevent their slipping. The webbing straps should be tightened and it is as well to use two cardboards over the specimens, including one with the corrugations running lengthwise.

There are various circumstances that make the final laying out of the specimens in the field impractical or even quite impossible. In windy situations, such as predominate in arctic, alpine and seacoast areas, rearrangement will always be necessary. Many plants that form dense rosettes are too heavy to keep their relative positions in the field press completely. (Fortunately such plants usually are not delicate and may generally be piled in without injury.) When biting insects are a serious pest, as is generally true in the boreal forest and subarctic, even the most stoical collector will do a worse job of laying out specimens in the field than indoors. Whenever collecting time is scarce—on short stops ashore from a boat or plane, stops on a trip with an inflexible schedule, or day trips up a mountain—the time needed for perfect cleaning and final laying out in the field is completely unjustified, for it may halve your collecting volume.

Under more favorable circumstances one must balance the risk of damage to possibly flaccid specimens against somewhat dirtier specimens of whole plants (since the first cleaning can hardly ever be complete), a slightly longer drying time that results from putting damp paper into the press, and the occasional annoyance of having to write on a sheet of paper that has parts of plants under the corner on which you wish to write. In using the direct layout method you put clean dry paper in your field press each day; but there is some advantage in using slightly damp paper from the previous day if the weather is at all conducive to wilting. Except where the plants are flaccid, somewhat better looking specimens almost always result from transferring them to fresh paper in the press; this is particularly true of herbaceous plants, which usually bear some loose soil no matter how carefully they were cleaned when collected. If soil particles are pressed on the leaves they cause permanent disfigurement.

The length of time that plants can be kept in the field press without damage varies widely with the weather. On scorching days in the Upper Sonoran regions of southern British Columbia we have found it advisable to press the morning's collections before lunch and those of the early afternoon at about 4 p.m. The presses are carried in the panel truck that is used as a mobile base. Usually in southern Canada, plants can be kept all day in the field press if it is kept tightly closed and out of the sun and wind. In the arctic, at the other extreme, we have kept plants up to eight days in good condition in a field press kept tightly closed and sheltered from the sun and wind. If necessary, in the arctic you can peel off a layer of mosses or other plants and place the field press under them within a few inches of the permafrost. Although long delays are not ordinarily recommended, they may occur if one is weather-bound away from one's base. It is much better in cool, moist climates to keep the plants fresh in the field press than to put them in presses without adequate heat, when browning always occurs. For short boat or plane trips away from base the presses may be left behind at a substantial saving of space and weight.

It will be seen from Figure 4 that the field press has both handles and a sling that serves as a shoulder strap; both are made from several layers of the fabric used for the construction of the field press. The handles are used for carrying the field press during active collecting. When the press is heavily filled, or when one is returning from a long hike, the sling, which is passed through both handles and slung over one shoulder, provides considerable relief. The sling serves two other functions. You can put your head and one arm through it and hang the field press across your back, leaving both hands free on cliffs and steep slopes or when pushing through dense thickets. The sling can also be put through the handles and pulled over the end of the field press, holding it closed—a feature that has proved useful when frequent loading and unloading of cars, boats or planes has been necessary.

Garments made from them are very light, yet warm. New closures, to improve windproofness, are also becoming available. You should check with all the suppliers in your region before making a choice.

Biting Insects

In much of the Canadian boreal forest and subarctic, biting insects are numerous enough to constitute an actual hazard to health rather than a mere annoyance. Collectors new to such country, who have acquired no immunity to the toxins of these insects, should treat them with respect. Some minor groups are intermittently annoying, such as the tabanids, which give a painful bite but are seldom very numerous, and the minute nosee-ums, which may alight on you in a cloud and cause a diffused burning of the skin that is, fortunately, seldom prolonged. However, the important insects are the mosquitoes (mostly *Aedes* spp.) and the blackflies (Simuliidae), of which several species will almost always be present in any northern spruce forest and muskeg area.

Although mosquito bites may be sharply painful at first and the irritation may last for some hours, the toxic effect is usually slight. If you wear tightly woven but loose clothing, closely fitted at neck and wrists, any good modern repellent on hands and face will generally reduce their annoyance to a minimum. An unlined parka with a hood and zippered front is a great help. A significant aspect of the mosquito nuisance is the psychological effect of hundreds of the insects humming about you. The novice must cultivate a philosophical attitude and remind himself that he will not actually be sucked dry; for otherwise he may spend more time in the unproductive occupation of swatting a minor fraction of the horde than he spends in his work.

To most people blackflies are a much more serious menace than mosquitoes. Being short-legged and more robust than mosquitoes they often get inside one's clothes unobserved and uninjured. They may bite repeatedly, unnoticed, for the

bites seldom start to itch for several hours and may then itch for days. Even the stoic who does not scratch the bites while awake may do so in his sleep; and the scratched bites often fester, making a sore that is slow to heal. Blackfly bites are much more serious on untanned skin than on the tanned and thickened skin of hands and face. Preventing the insects from getting under your clothing is therefore most important. When applying repellent, pull up your sleeves and loosen your collar, and apply the material several inches above the wrist and low on the neck. Blackflies will not cross such a barrier. A gaping buttoned shirt invites trouble. Cover it by a hip-length zippered jacket of light material or an unlined parka. Fasten trousers securely inside your boots. If you wear two pairs of wool socks, one inside and one outside your trousers, a blackfly can seldom penetrate by this route. Always fold the trousers at the back of the leg, for the fold is always higher than the rest of the cuff; if it is in front it is easily pulled out of your boot when you bend your knee.

Repellents are seldom effective for more than three hours, and wear off considerably faster when you perspire freely. Always carry a bottle of repellent—in a buttoned pocket to prevent accidents. When you must use it in the field, take care to pile cap, glasses, wrist watch, etc., on the field press, so that nothing will be lost.

Special Collecting Techniques

Some of the information in this section involves pressing and drying rather than collecting. However, some duplication will be eliminated by including it here. Moreover, since some of the precautions must be taken before the specimens are pressed, their discussion at this point is not seriously out of order.

Aquatic plants.—Although some aquatic plants are firm enough to be handled like land plants, many others, such as *Ruppia, Zannichellia,* and some species of *Potamogeton* and *Utricularia,* are so delicate that surface tension clumps all the leaves together as soon as they are taken from the water.

Float such plants onto sheets of paper; raise the sheets horizontally until the plants are caught on them and then gradually tilt and withdraw the sheets. Sheets of herbarium mounting paper or other high quality paper should be taken on field trips for this purpose. Cut the sheets in half or quarter size for this purpose, as it is hard to float out several small plants on a single large sheet. Preferably, wash the plants in the field, bring them back to your base in mass in the field press, and float them out in a sink. If there are no facilities for floating plants in camp, it may be best to float them in the pool from which they are collected. If there is much wind, floating plants in the field may be very difficult, and you may need to transfer the plants to a more sheltered pond.

For filmy aquatics prepasted mounting paper has been tried with some success at this institute. Not all the dry paste washes off in the brief immersion of the paper. However, to prevent adhesion of the newsprint to the mounting paper, cover the specimen with wax paper.

Many aquatics are covered by a mucilaginous slime, often the product of microscopic algae, which sticks them to the mounting paper. Cover very delicate species with wax paper; otherwise they may adhere more firmly to the newsprint than the mounting paper and you may ruin the specimen in trying to remove it from the paper. Aquatic plants dry so quickly that, although the wax paper halves the drying rate, the delay is not serious. These plants may adhere so firmly to the mounting paper that they need only reinforcement at a few points to complete the mounting. See also discussion of floating marine algae in Chapter 4.

Sticky plants.—A few plants, such as *Drosera*, are so sticky that when they dry it is hard to open the newsprint to remove them. Unless you experiment first with a very few plants, *do not* try to avoid this problem by inserting waxed paper on one side of the specimens before drying them, for some plants, including some species of *Drosera*, stick more firmly to wax than to plain paper. With some of these plants

you might try the phycologist's practice of covering the specimens with muslin, as described in Chapter 4, but there is no certainty that the technique will work. Until better means can be devised, it seems best to press the plants in the ordinary way, and later to pull back the paper at an acute angle, rather than to lift it up, easing it away from the plants with a sharp knife where necessary. If some paper cannot be freed by this means, dampen it with a wet cloth, or use a wetting agent, and peel the paper off as soon as it loosens. If this is done quickly the specimen remains almost perfectly dry and will not curl. This technique also applies to various berries.

Fleshy plants.—Many fleshy plants dry very slowly, partly because of a heavily cutinized epidermis but perhaps chiefly because the water is colloidally bound within the cells. Occasionally the delay merely calls for patience. We have had specimens of some populations of *Montia parvifolia* in the presses for a month with nearly constant heat yet the specimens finally came out with excellent color retention. Unfortunately the delayed drying is often more serious. *Portulaca* may be pressed in flower and removed in mature fruit with leaves shriveled, detached, blackened and sometimes moldly. *Opuntia* may produce etiolated shoots that grow right out of the press and bear little resemblance to the original specimen.

Large fleshy plants may sometimes be split and most of the pulpy contents either left in place or removed. This method has obvious limitations. It is too tedious to use on small plant parts; and it would take both skill and fortitude to split any great number of *Opuntia* pads covered with needle-sharp, barbed spines.

For many fleshy plants the key to the problem of drying seems to lie in the fact that cells that firmly retain their contained water in life lose it readily when they are killed. It remains to find the most effective killing agent, one that is cheap, readily available, does not discolor or otherwise modify the specimen seriously, is not irritant, and preferably leaves no residue on or in the specimen. No fully satisfactory killing agent seems to have been found, although many have been suggested. Limited trials at this institution, with *Portulaca oleracea* as a test plant, suggest that a brief dip in boiling water or dilute methyl or ethyl alcohol (25-50 per cent) is about as effective as any more elaborate killing agents. Prolonged boiling must be avoided, since it simply causes soft tissues to disintegrate. For small-leaved plants a dip of 5 to 30 seconds seems to be adequate. For large cacti, etc., longer periods are needed to ensure adequate penetration, but large variations sometimes have little effect on the quality of the specimen. If for killing a plant you use any chemical that leaves a residue on or in the plant, include a note to that effect on the label, for the treatment might affect a biochemical test applied at a later date.

Barrel cacti and similar difficult subjects must be treated differently. Slice off a superficial patch large enough to show any pattern, for example, of spine arrangement, and cut a thin transverse slice to show the form of the stem. Photographs of the whole plant are important. Although you will wish to keep a few cactus flowers attached to show how they are borne, most flowers should be detached and pressed on separate sheets, some face down and some on their sides. If they are pressed on the same sheet as the rest of the specimen the petals will usually wrinkle from inadequate pressure and their drying may be delayed. By themselves, many cactus flowers dry readily and retain their color well.

Spruce and hemlock.—Christmas-tree buyers as well as botanists know all too well the way *Picea* and *Tsuga* shed their needles once they start to dry. This shedding may be prevented by killing the cells at the leaf base before abscission starts. Unfortunately all the killing methods that have been suggested cause considerable browning of the foliage. Chemical treatments to prevent the browning or to substitute other green compounds for the natural green of the needles have been suggested, some of them very elaborate and quite impractical for use in the field. All chemical treatments have some inherent drawbacks: they may change the appearance of leaves or twigs sufficiently to suggest genetic differences; they may interfere with the later application of chemical tests for diagnostic or other purposes; and any foliage parasites on them may be rendered useless as specimens.

Most collectors press these plants without treatment and later put the loose needles into packets mounted on the sheets. This method does not make a pretty specimen, but the twigs and needles are preserved with a minimum of change and the specimen is satisfactory for taxonomic purposes. An alternative that has been used with some success at the Institute is to spread adhesive on the back of the fresh specimen, lay it on a sheet of mounting paper, cover it with wax paper (in case surplus adhesive should well up between the needles) and press it in the ordinary way. The needles separate from the stalk but are held in position on the sheet. This simple method is very satisfactory on day trips, when the specimens are processed in a well-equipped preparation room; but it is unlikely to be popular on long trips, since it involves taking along the paraphernalia for mounting and means a tedious extra job at the end of the day's work. It is somewhat less satisfactory for spruce, with its needles scattered round the twigs, than for hemlock, with its two-ranked needles; for some of the needles on the upper surface will come loose unless an undesirable excess of adhesive is used.

Arctic and alpine collecting.—In arctic and alpine collecting strong winds often make the use of the field press difficult. The individual plants of a species too, may be so widely scattered that you may cover as much as a mile in securing an adequate collection. Under these circumstances it is impracticable to try to lay the specimens into the field press in the orthodox manner. Fortunately few arctic-alpine plants are so delicate that they must be handled with great care. Most are stout, firm-leaved and protected by hairs. When working under such conditions fill the specimen side of the press with enough sheets to last the working period. As the plants are collected slide them down into the folded sheets.

After a few sheets have been used it becomes hard to tell at a glance which is the inside of the sheet and which the gap between two sheets. Be sure, then, to number the sheets consecutively before starting, putting the numbers inside and in a standard position. This method has the added advantage of making it easier to find the right sheet as you gradually add to a collection of a widely scattered plant in the course of a day. One soon remembers, for example, that *Arenaria rubella* is on sheet 4, *Cardamine bellidifolia* on sheet 6 and *Pedicularis flammea* on sheet 11.

When the wind is exceptionally strong it may be impossible to use the field press at all. Take along some plastic bags and drop the plants into them. Inevitably species become mixed in the bags, which means tedious sorting later; but this is better than wasting the day. The mixing can be minimized if you put collections that can be completed at a single colony into a paper bag (about 4-pound size), and then put it into one of the plastic bags. Plants that cannot easily be cleaned as they are dug should also be put in individual paper bags to prevent soiling other plants. Use individual paper bags also for fragile plants that might become damaged if left loose in the main bag. Always put rusted or smutted plants into individual bags, for mixing of the spores can cause serious difficulty for the mycologist who examines the specimens. If you use about four plastic bags, say two in each pocket of your parka, and can remember always to put a species into the same bag, the work of sorting will be greatly reduced.

Pressing and Drying

General Principles

These two processes are discussed together because pressing techniques depend to some extent on the drying facilities that are available.

Plants must be pressed firmly and continuously during drying, or the leaves will wrinkle. For many generations botanists dried their plants without heat, depending upon a daily changing of felts and papers for removal of moisture. This method is so time-consuming that it seriously limits the volume that can be handled, and it never yields really good specimens except of the relatively small proportion of plants that dry very readily.

Today nearly all botanists use heat in some form to speed the drying process. To secure the best retention of color with freedom from brittleness, dry the specimens rapidly but with only gentle heat. The role of heat in the drying process has not been fully appreciated, and some remarkable and completely erroneous statements on its use have been made. Too high a temperature in the press causes both browning (incipient scorching) and brittleness. The term brittleness itself has been used loosely. When specimens break up readily it is sometimes due to inadequate pressure, which causes wrinkling of the leaves. Such specimens break up from the mere weight of other specimens filed on top of them. A high or even moderate temperature may cause browning through oxidation processes if there is inadequate air movement to carry away the moisture that is withdrawn from the specimens. Drying without heat causes a slow killing of the plant cells and oxidational browning inevitably results. As explained earlier in this chapter, during discussion of the field press, a delay in the application of heat after the plants have been pressed always causes browning, for drying (and killing of the cells) starts as soon as the plants are in the press. Discoloration due to slow drying affects the color not only of leaves and flowers, but sometimes even of hairs. In a recent monograph a distinguishing character of *Heuchera chlorantha* was stated to be the brown hairs in dried specimens; but in specimens dried by suitable methods the only brown hairs are those on senescent leaves or those where overlapping delayed drying.

Removing the water quickly and safely from the specimen necessitates a steep water-vapor pressure gradient between the specimen and the outside air. There are two ways to steepen the gradient: decreasing the moisture content of the and anatomical material should be preserved according to the instructions of the person who will eventually study it; different working techniques may require different fixing solutions, plant parts and developmental stages.

Packing and Shipping Dried Specimens

Specimens that are dried in the laboratory are generally sorted at once into folders, for identification and labeling. Specimens dried in the field must be packed securely for shipment. Cartons such as those used for cans of condensed milk are a convenient size for holding specimens, being a trafle larger in area than the folded newsprint. A good procedure is as follows. When a pile of specimens becomes about 6 inches high place a corrugated cardboard (a battered ventilator will do) on a table and true up the stack of specimens on it. If there are small specimens or conifers with loose needles in any of the sheets, wrap them in newsprint before bundling. To prevent the possibility of plants slipping out put duplicate sheets with their open sides into the hinge side of the master sheet. Then put a second cardboard on top of the stack. Cut a length of cord or of cotton tape long enough to go once lengthways and twice sideways round the stack and tie a loop in one end. Now loop the string sideways round the bundle towards one end, pull it tight and cinch it with a half knot; loop lengthwise, but, without completing this loop, hold the cord down and make a lateral loop; tighten this loop round the cord where it is held and cinch again; finally, complete the longitudinal loop by drawing the junctions of the two lateral loops toward each other and fastening with several half knots.

Such a bundle holds the specimens firmly enough to prevent them from sliding against each other or slipping out of the papers. Ship bundles in cartons if there is a reasonable certainty that they will not be exposed to moisture. Otherwise, cover them with extra wrapping or ship them in suitable plywood boxes. We use field boxes of ¼-inch plywood with outside cleats and screw-down lids; inside dimensions are 18×12¼×20 inches. These boxes are ideal both for shipping supplies into the field and for shipping specimens back. We pack the bundles of specimens flat and fill the small space left at the end of the box with folded cardboard or miscellaneous small items.

Processing Dried Specimens

Preparing Labels

When the collections have been identified the plants may be laid out for mounting. As soon as it is seen how many duplicates there are, the final labels may be made (Figure 2). In the Institute, if there are only a few duplicates the labels are typed individually; but if there are many the duplicate labels are printed from stencils. A stencil will hold six labels. The master labels are therefore sorted into groups of six for which nearly the same number of copies are needed. A stencil is cut for each group of labels and enough sheets are run off to provide for the largest group. The printed sheets are cut up and the labels returned to the herbarium. The duplicates are now ready to be sent out in exchange and the master sheet is mounted and inserted in the herbarium. If you expect much delay in getting the labels printed, it is a good idea to postpone laying out the specimens; estimate the number of labels needed and send the master labels for duplication as soon as the collections are identified.

Laying Out for Mounting

Although it is desirable to have a liberal amount of material on the sheet, the sheet must not be crowded. There must be space for the label, perhaps also for a field label. As the years go by, a succession of specialists may examine the sheet and each may attach a small annotation label.

Although annotation labels are generally attached by one edge only, they should not overlap the specimen. Furthermore, someone may sooner or later remove flowers for boiling and dissection, or dig seeds out of a capsule. This material is put in a packet attached to the sheet, so that the next examiner will not have to mutilate the specimen further. In, for example, *Isoëtes*, microscopic mounts are needed for identification; and these preparations may usefully be ringed and attached to the sheet in packets. The specimen then, should not occupy more than about three quarters of the sheet. When the plants are very small it is neither necessary nor desirable to pack a very large number on the sheets. Put enough on each sheet to show the variation in size and other characters and to provide ample flowers and fruit. If you overload exchange sheets the mounter at the receiving institution may simply mount what he considers adequate and throw out the rest. Rather than risk such waste make extra duplicates.

Lay out the master sheet directly on herbarium mounting paper. Lay out the duplicates on sheets of newsprint or other light paper, which is bought cut to size in unfolded sheets when the volume of exchange is great. As a check against the mixing of labels, write the collection number on each sheet.

When you consider the cost of materials, field travel, salaries, and other incidentals, the actual value of fully processed specimens is often more than a dollar per sheet; if there has been much travel by chartered airplane, the cost can be much more. The careful laying out of duplicates to avoid waste is therefore a matter of economic as well as scientific importance.

Mounting

Except for occasional minute plants, which may better be placed in packets, stick specimens to mounting paper and then reinforce them with strips of linen tape or, preferably, by the plastic strip method. The following materials are needed.

Mounting paper.—The standard size is 16½ by 11½ inches. A good quality paper that will not become brittle with age is essential. The weight should be fairly heavy, to reduce flexing when mounted specimens are picked up. A mat-surfaced paper provides better adhesion than a smooth paper.

Mounting board.—A piece of plate glass, sheet aluminum, arborite or other inert and water-resistant material about 24 by 18 inches is required. The surface must be smooth and easily cleaned.

Adhesive.—A neutral, opaque library paste has been found satisfactory. A neutral adhesive minimizes the change in flower colors, the pigments of which are often indicators. It is difficult to prevent mold growth on neutral pastes; consequently most commercial pastes are strongly acidic. Various pastes and mucilages may be used provided that they do not become brittle with age and can be easily cleaned from the mounting board. The paste should be freely miscible with water, since it is necessary to dilute it occasionally on the board, especially when the air is dry and it may quickly become very stiff.

Brushes.—An inexpensive 1½-inch paint brush is ideal for applying adhesive to the mounting board. A fairly large artists' brush is useful for applying glue to individual leaves that are too flexuous to place in the film on the mounting board.

Forceps.—Forceps with spatulate tips, such as stamp collectors use, are excellent for picking up specimens. The type with offset tips is particularly useful for applying gummed linen strips.

Gummed linen tape.—Gummed linen tape of the type used for repairing books is cut into strips about ½ inch wide with the warp running lengthwise. The tape should be pliable and have good adhesive properties.

Plastic stripping.—The method used at the Institute is that described by Archer (Rhodora 52:298. 1950). The plastic is made of the following ingredients:

Ethylcellulose (ethocel) standard 7 cps	250 g.
Dow resin 276 V-2	75 g.
Methanol	200 cc.
Toluene	800 cc.

The plastic is dispensed from a trigger type of oil can with a small nozzle. The nozzle should be provided with a cap with a pin in the center, which should be replaced when work is stopped for any great length of time. Copper or copper alloy (brass or bronze) cans or internal parts should be avoided, since their use discolors the plastic.

Mounting procedure.—Moisten the brush and mounting board with water and apply a thin coating of paste to the board. The best thickness of the layer of paste depends upon the coarseness of the specimens to be mounted. The size of the patch will naturally depend upon the size of the specimens. Place the specimen on the paste and gently tamp it down to make sure that the lower surface is well coated. Then carefully pick up the specimen. Peel the leaf surfaces away from the paste slowly, to avoid breaking, and drop the specimen gently on the mounting paper in the desired position. Delicate specimens need a thinner mixture of paste than coarse ones. Special techniques for specimens that are hard to handle will soon be developed through practice. If any pasted leaves tend to droop, a slight upward flip just before the specimen is lowered into place will ensure that the leaves land fully extended. Leaves that do come down somewhat buckled can be extended by running the forceps under them. Keep a glass of water handy for cleaning off the forceps and diluting the paste. Some grasses and sedges droop too much to be handled by flipping. In handling such plants let them hang vertically and bring the paper slowly into contact. With very flaccid specimens, such as the linear-leaved species of *Potamogeton*, spread a layer of thinned paste on one surface and lower the mounting paper on top of them. When the sheet is lifted the specimen will come with it.

The specimen should be located carefully on the sheet, preferably so that it does not come within an inch of the edge at any point. Do not mount solitary small specimens or packeted specimens in the center of the sheet, since, if several accumulate in one folder, there will be a bulge at this point, space may be wasted and specimens may be damaged. Practice a rotation in mounting such specimens; for example, start at upper left, then place in upper right, middle left, middle right, lower left, lower right. Although it is generally better to have the base of the plant toward the bottom of the sheet, the position should be varied in plants that have very thick bases, to ensure that the sheets stack evenly and occupy the minimum of shelf space.

If your own technician does the mounting he can be trained to keep most of the inflorescence out of the paste and to attach it carefully with plastic stripping. However, this method is seldom practicable with specimens sent out to relatively unskilled contract mounters.

Fragments of specimens, very small plants, seeds, and extra flowers or fruits may be placed in packets and pasted to a convenient part of the sheet.

The label is preferably attached to the lower right corner of the sheet. Paste it by a narrow strip along the top edge or, if the specimen is so large that there is insufficient space for the label, attach it by the right-hand edge and allow it to overlap the specimen. Do not paste down the whole label as this generally makes the corner of the sheet curl.

After the specimen has been pasted down and the label attached, cover the sheet with a piece of wax paper, then with a felt, a heavy cardboard and any convenient weight. Additional specimens, each covered by wax paper and felt, may be stacked under the cardboard and weight. The specimens should be left to dry under the weight for several hours or preferably overnight.

After they are dry, remove the specimens from between the wax paper and felts and reinforce them at various points to ensure that the paste does not give way with flexing of the sheet. Use either linen tape or plastic stripping and reinforce the stem every 3 inches or so. Reinforce large leaves near the tip and, if wide, on the sides. Also reinforce large inflorescences at several points. Try not to conceal areas of possible diagnostic value. Stem reinforcements should be in the middle of an internode. If tape is used do not cover the actual tip of the leaf. In reinforcing the inflorescence try to ensure that a particular structure is not covered repeatedly.

If tape is used, see that the strip extends about half an inch beyond the part to be covered. Moisten the tape and hold it down firmly with bent forceps. If the fingers are used it is almost impossible to avoid the occasional grimy mark on the sheet. Long tapes covering broad masses of grass leaves and stems give almost no support and should be avoided whenever possible. *Never use cellulose tape or surgical tape for reinforcement.* The adhesives in these materials ooze out at the edges of the strip, picking up dirt and disfiguring the specimen. Cellulose tape also becomes yellow and brittle with age.

For neatness, strength and speed of application, plastic reinforcement is better than linen tape. Being fully transparent it does not conceal details such as leaf teeth. If a specimen reinforced with this material is put under strain the paper tears before the plastic breaks. With a little practice you can apply it from the oil can very quickly and neatly. Apply a strip of plastic across the stem or other part and anchor it to the sheet on each side. With large leaves put a circular blob here and there, half over the edge. A blob squirted into a mass of fibrous roots will anchor them more firmly and much more neatly than a long linen strip.

Occasionally it is necessary to sew a very coarse stem, a cone, a heavy piece of bark or some other large specimen to the sheet. Heavy linen thread should be used. Pass it twice or more over the specimen and knot it on the back of the sheet. With some objects, such as large pieces of bark or *Opuntia* pads, you may have to drill pairs of small holes through which to pass the thread. Use strips of gummed paper to cover the threads on the back of the sheet and so prevent damage to the specimen immediately below.

Herbarium Packets

Packets of the style shown in Figure 10 are used at the Institute in the following sizes (inches): 1½×¾, 3×1½, 4×2, 5×3, 5½×4½, 9½×3½. This selection covers the requirements for mosses, lichens and fungi as well as for vascular plants. This style of packet was adopted mainly because it is easily made by machine. If they are purchased in large lots, such packets are much more economical than hand-folded ones. The bottom flap is cut so that it almost exactly fits inside the folds of the other three. It is folded in first; then the side flaps are folded across and finally the top flap is folded down. The weight of specimens on top will

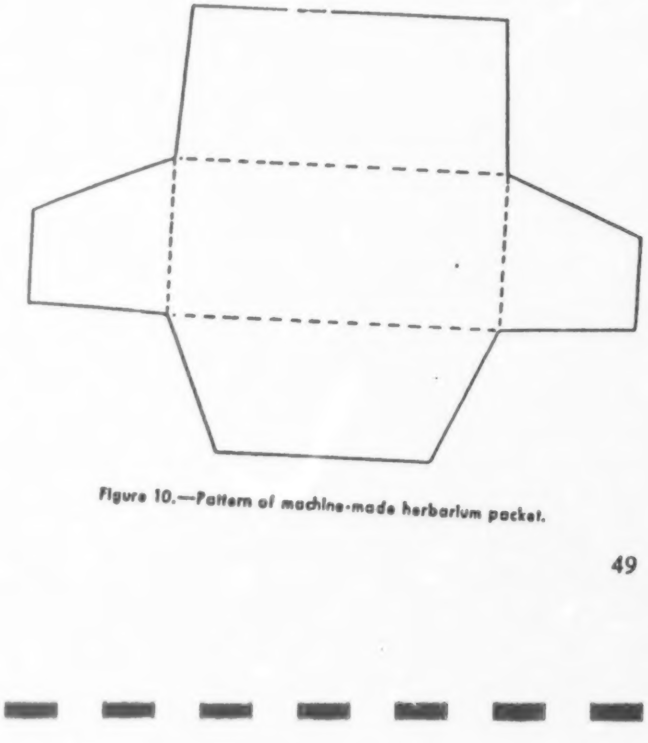


Figure 10.—Pattern of machine-made herbarium packet.

CHAPTER 3

MOSSES AND LIVERWORTS

Collecting and Drying

The bryophytes (mosses and liverworts) are among the simplest plants to collect and handle; but several points must be observed if the collector is to make the best use of his time and opportunities.

These plants may be collected directly into paper, cloth or plastic bags or into folded newsprint in the field press, provided that they come cleanly off the substrate. When they grow directly on mineral soil they should be washed in the nearest pond or stream before they are put into containers; otherwise the drying soil will sift through the specimens spoiling their appearance completely.

Collect plenty of material of each species, enough for at least two generous packets if the specimens are to be sent away for determination, to ensure adequate specimens for yourself and the identifier. If exchanges are contemplated the quantity must naturally be increased. A further reason for collecting liberal amounts is that what seems superficially to be a single species may actually contain one to several inconspicuous admixed species. Even the professional bryologist is accustomed to finding an extra 5 to 10 per cent of species in the laboratory above those that he saw in the field. The general collector, taking specimens on the basis of habitat and gross appearance, may expect a substantially higher proportion of unrecognized species. Ample specimens not only ensure that most of the scarce species will be picked up, but increase the likelihood that each will be adequately represented.

There is some advantage in collecting species individually, since only by so doing can their individual abundance in a habitat be recorded; but the general collector, with little knowledge of the mosses, can safely distinguish relatively few species and should not spend too much time trying to separate them. I recollect painstakingly segregating mosses during my first field season in the north, only to find out later that some of my specimens contained two to five species. It is much more important, where time is limited, to *collect by habitat and record the habitat in detail.* Mosses are particularly sensitive to moisture supply. Thus permanent and temporary pools have different species, as do still and flowing water or upper and lower parts of a shore. Different species occur on the sunny and shady sides of a log or tree, and at different heights up a tree. Shade may be important directly as well as through its effect on moisture; thus some mosses are adapted to dimly lit caves. The substrate is important and should always be recorded. Different species may favor acidic or basic rocks, clay or sand, rough- or smooth-barked trees. If possible record the species of tree from which a moss is taken or include some bark or a twig. Species that grow on twigs should be taken twig and all.

Record the habitat data of the last paragraph together with any others that seem appropriate, and also the date and locality. Write the data in pencil on a slip of paper and put it in the specimen bag, or put the collection number in or on the bag and record the data in a notebook. If all the specimens from one habitat are put together under a single number, as they are sorted out add supplementary letters to denote the individual species.

Carry bags representing the individual sites and habitats in a large plastic bag or a haversack, or in the field press if one is being used. On return to base dry the collections reasonably promptly. The form in which they are dried is not critically important, for mosses can easily be relaxed, by wetting, at any future time, for sorting, identification and flattening. Thus the general collector, with little time to spare for handling bryophytes, may be best advised to collect directly into paper bags of 2-pound size and to dry the specimens in these bags. If a field drier of the type described in Chapter 1 is in use, place the open bags on the floor inside the drier frame. When the specimens are dry fold the tops of the bags down, and pack the bags into a box in such a way that they cannot shift. Any other source of steady but gentle heat can be used for drying. Specimens cannot be dried in plastic bags, since most of the materials used for such bags are almost impermeable to water vapor; thus drying can take place only through the top of the bag and will be slow even if it can be held wide open.

If time and facilities permit, flatten the specimens somewhat, so that they may be put into packets with the minimum or further processing. Many species may be pulled or teased apart into a layer about ¼ inch thick. Species that form a compact palisade may be split apart vertically into thin sheets. Spread prepared specimens on newsprint, either one collection to a sheet or with the collections separated by pencil lines, and mark the specimens with their collection numbers. Press them *gently* in a standard plant press (Chapter 1) and dry them as you would other pressed specimens. The press should be just tight enough to guarantee that the contents will not slide about. If the amount of pressure is used that is necessary to produce good specimens of vascular plants the mosses may be so flattened that diagnostic characters such as stem shape are altered, and they may be so matted together that examination and the sorting out of mixtures are rendered more difficult. If so few mosses are taken that it is undesirable to devote a special press to them simply place them between felts in a dry place, with a small weight on top of the stack, and change the felts every day. Stack the dried specimens in their papers and bundle them firmly between corrugated cardboards, to prevent them from slipping. The extra time and space involved tends to discourage the general collector who is living in camp far from laboratory facilities. If he is in a relatively inaccessible region to which he is unlikely to return, he must make the best use of his time and is advised to stick to the paper bag method, which is quicker and less prone to accidents.

Processing Dried Specimens

Place the dried and identified specimens in paper packets about 5¼×4¼ inches, of the type described in Chapter 1. Type the data on a label and stick the label to the face of the packet. The packets may be either mounted on standard sheets, as described in Chapter 2 for fungi, or filed on edge in drawers. The latter method conserves some space and is quite convenient for a small collection; but it has its disadvantages. All the packets should be almost exactly the same size, which involves repacketing many specimens received from other institutions. This method also makes it more difficult to see at a glance what the recorded distribution of a species may be.

A method of mounting that has been tried with some success at the Plant Research Institute is the use of herbarium sheets with pockets across them into which the specimens are tucked (W. G. Dore. Herbarium sheets for filing mosses. Bryologist 56: 297. 1953). This device is rather similar to one used by philatelists for storing duplicate stamps visibly and accessibly. The herbarium pocket sheet, which, incidentally, was developed quite independently of the philatelists' device, has, of course, much larger pockets. Five pockets, formed of strips 2¼ inches deep, run across the sheet. They are glued along the bottom 3/16 inch and the ends are secured by being folded over in a tab ¼ inch long and glued to the back of the sheet. The lowest pocket is flush with the bottom of the sheet and there is a clear space between the pockets of ¾ inch; this spacing leaves 2¾ inches above the top pocket, just allowing insertion in it of a packet 4¼ inches high. If specimens are in various sizes of packet it is preferable to put smaller ones at the top. Very large packets must, of course, be put in lower pockets.

This method of filing combines visibility with flexibility. A redetermined specimen is simply lifted from its pocket and tucked into its appropriate place. In a small collection different species of a genus may be grouped together without compromising the future adoption of a more elaborate filing system. You may start with one specimen of each of three species. As you acquire more specimens of one of them you will assign them to a separate sheet. Eventually geographic segregation of each species may be adopted. On the face of it this seems to be an ideal system of filing; but we are not yet prepared to grant it unqualified approval. As noted in Chapter 2, under Insertion, these sheets were tried quite extensively in the mycological herbarium and found unsatisfactory. Although the packets jam tightly into the pockets at first, the pockets inevitably stretch in time. This slight loosening may not be very serious with moss packets, which are generally very light and may stay in position when the sheets are tilted; but some mycological specimens are relatively heavy, and in this institution a slide is often included in the packet. Such packets cascade out of their pockets if, as is usual in a quick search, the sheets are turned like the pages of a book rather than kept strictly horizontal. The latter method of handling is particularly tedious in a long search, for, to keep the sheets in sequence, each sheet, after scrutiny, must be placed beneath the sheets already examined; or else the whole sequence must be reversed after the examination is completed. Such a procedure quickly causes the sequence to become badly muddled. The pocket sheets will probably prove unsatisfactory when the moss collection is in more active use than at present; but the system deserves further trial.

CHAPTER 4

LICHENS

Collecting

Collecting lichens is commonly considered so simple that information on the subject is scarce. Consequently the few important precautions are often overlooked. The following advice is intended for the beginner and the general collector. More-detailed instructions will be found in a forthcoming publication by W. A. Weber and S. Shushan (Field and Herbarium Techniques in Lichenology. University of Colorado Studies, in preparation).

For collecting purposes, lichens are conveniently divided into three groups. Crustose lichens grow flat and are intimately bonded to the substrate. Foliose lichens have leaflike blades that are more or less flat on the substrate and often have multiple connection to it although they are not inseparably united to it. Fruticose lichens have a small basal attachment and a stemlike thallus that is often freely branched.

Lichens may be carried in the field by any convenient means, but if rock lichens are taken in numbers the substantial weight makes a good-sized rucksack essential. Always collect species individually. If they occur so mixed that they cannot easily be separated, collect enough of the mixture to make an adequate specimen of each.

Although ample specimens should be taken, you are advised against removing far more than you need, especially of crustose species and especially in populous and well-botanized regions. This may seem to be a very trivial point;

but lichens grow extremely slowly and rare species may easily be eliminated from an area by overcollecting. The dressed stone of Fort Prince of Wales, at the mouth of the Churchill River, built between 1732 and 1771, is still much more lightly lichenized than the native rock. I also recall a foot trail through Cladonia parkland just inside tree line, which had been abandoned because it ran between two spruce trees that had grown together. It looked as fresh as the new trail, but examination of the tree branches showed that it had been abandoned for at least 20 years. Even much further south there are rock cuts and slides that remain bare for many years.

Crustose Lichens

Collect crustose lichens wet or dry and, to prevent damage from occurring as they are carried home, wrap them individually in tissue paper as they are collected. Toilet tissue is the cheapest and most convenient wrapping material. Never wrap lichens in absorbent cotton; it becomes tangled in the specimens and causes more damage than it prevents.

Crustose lichens must obviously be collected with a portion of the substrate. If the substrate is a tree trunk or a large branch, cut off a section with a chisel or a heavy knife. If the lichen is on a twig, cut off a section of the twig with a knife or pruning shears; the twig may later be split if it is too bulky to fit easily in a packet. If the species is growing on soil, carefully slide a large knife under it, using a sawing motion to reduce the needed pressure and minimize the risk of the specimen crumbling, and lift the whole thing onto toilet paper. Wrap it and put it in a packet or shallow box.

Crustose lichens give most trouble when they are on rock, for they must be collected with a hammer and cold chisel. If the substrate is sedimentary rock you will have little trouble removing thin but sufficiently large flakes of stone, with a substantial portion of the lichen. However, to secure

a reasonably large patch of a species growing upon igneous rock without taking an inordinate weight of rock requires skill and practice. One hint is offered to those unfamiliar with the use of a cold chisel. Do not grip it rigidly with all four fingers, but hold it, as low down on the shank as practicable, with the third and fourth fingers doing most of the work and the first two fingers slack. Then if, as may happen sooner or later, the hammer glances off the chisel, the first finger or knuckle gives under the blow and little damage is done. A heavy hammer of about 5 pounds and chisels about 12 inches long are sometimes recommended. This recommendation is perfectly sound to the extent that it makes it easier to get large flakes of rock instead of little chips, and it is satisfactory for the collector who expects to work within a few hundred yards of his car. But the carrying of such tools is too much to expect of the general collector, who may cover many miles on foot in the day's work and be loaded with miscellaneous equipment. A 6-inch chisel with a ½-inch blade may be used if weight is at a premium. If no digger is carried for general botanical collecting, the standard pick-headed geological hammer of 2-pound weight is recommended. Otherwise a ball-peen hammer may be preferred; it is more compact to carry and has a better face for use on a cold chisel.

It is very important that ample material be taken, preferably about enough to cover a card measuring 3×5 inches. More should be taken to supply the identifier if the specimens are sent away for determination. Secure part of the edge as well as the interior of the colony. Distinctive characters may be obscured in small fragments.

Foliose Lichens

Foliose lichens are collected much like crustose species, it usually being desirable to include some of the substrate. However, a compromise is necessary when the lichen is on a rock, where the attempt to take the underlying rock with it may result in the specimen being severely broken up. Then it is better to cut the specimen away and record the type of rock.

Fruticose Lichens

Fruticose lichens are handled somewhat like mosses because the growth tends to be vertical rather than horizontal. They are usually removed quite easily from the substrate, but take care not to cut off the base of the plant. Dig up species growing on soil and tap the soil off the base.

Foliose and fruticose lichens usually need to be flattened; otherwise they make bulky specimens and are inclined to shatter in the packet. If preferred, pack them into boxes and later flatten them in the laboratory. If possible, collect them when they are moist and pliable. In dry weather they become extremely brittle, so handle them as little as possible in this condition. The general collector can usually so arrange his program that he collects lichens during or soon after rain, fog or heavy dew. If they must be collected in dry weather first relax them by sprinkling with water. A polyethylene squeeze-bottle allows water to be applied economically, a point of some importance if you are collecting far from a source of water. Spread foliose and fruticose species on newsprint and carry them in the field press, but be sure to divide them into portions that will fit into a packet before they are dried; if separated when dry they will break up badly. Press them gently, as you would press mosses.

Drying

To prevent growth of mold, dry lichens thoroughly as soon as they are brought back to the laboratory or field base. Those in presses are dried by any of the means described in Chapter 1. Wrapped specimens may be spread out to dry over any available source of gentle heat. Various means of drying are described in Chapters 1 and 2. If no heat is available spread the specimens out in a warm, well-ventilated place, until they are thoroughly dry.

Labeling

Full label data should be included with the specimen or in the field notebook. In addition to the date, locality, collector, and collection number if used, describe the substrate and habitat carefully. If the substrate is soil, give the type: sand, sandy loam, clay loam, clay, humus or bog. Specimens on trees will include some of the bark or wood, as a rule, but the identity is generally much less obvious from a small sample than from the tree. Identify the tree, for some tree lichens are extremely specific in their requirements. The distance above the ground may also be significant for tree lichens. Identify rock substrates as fully as possible. The local geological sheet will often supply or confirm this information; but if you cannot do your own identifications, ask a geologist to help you. Igneous rocks that to the uninitiated pass as granite may contain a bewildering array of included minerals, which may not all harbor lichens to the same degree. Give pertinent data on slope, direction of exposure of tree trunks, cliffs or steep slopes, position relative to high water mark on stream banks, distance from high-tide mark on sea coasts (species may vary in tolerance to salt spray), proximity to spray from waterfalls or to seepage water, or any other local factor. Also, record the approximate altitude in mountain country.

Since many microhabitats may be visited in the course of a day, it may be necessary to record the habitat of each specimen as it is collected. If the details are put in the field notebook and only the number put in with the specimen much time may be saved in the field; a specimen may be written up by referring back to an earlier collection and noting only how it differs. However, full field labels save some time later when the final labels are typed.

Processing Dried Specimens

Put foliose and fruticose lichens directly into herbarium packets such as those described in Chapters 1 and 2. Stick crustose species to a piece of thin card very slightly smaller than the inside dimensions of the packet. This practice gives support to a fragile substrate, which in disintegrating would cause the specimen to break up. It also prevents the specimen from being damaged by abrasion due to it sliding about in the packet.

Whether the packeted specimens are mounted on herbarium sheets or stored in filing drawers depends upon the scope of the herbarium and the preference of the curator. The arguments are very much the same as those that apply to fungi and mosses. For a discussion of them the reader is referred to Chapters 2 and 3, particularly the former.

CHAPTER 5

ALGAE

Fresh-water Algae

Collecting

Fresh-water algae are almost all microscopic. They are abundant in almost all bodies of water, but the species vary enormously with the environment. Thus it is important to record whether the water was standing or flowing, and whether the underlying rock was basic or acidic. Although such algae will generally be sought in lakes, ponds and rivers, they occur also in soil, on moist rocks, on tree trunks, even on or in living leaves, and in the superficial layers of mountain snow fields where a common species causes the phenomenon of pink snow. However, the general collector, to whom these brief notes are addressed, will make most of his collections in bodies of free water. From the collector's viewpoint these algae fall into two classes: the filamentous or colonial forms, which are readily picked up and dropped into vials; and the free-floating unicellular species (plankton), which must be secured with the aid of a net of bolting silk or nylon.

Put specimens into small vials, preferably about ½ inch in diameter and 1½ to 2 inches high. Glass vials should be corked, since screw tops seldom give a perfect seal. Small vials of flexible plastic, with a press-on lid attached by a hinge, are now available. These seem to give a perfect seal and are very convenient. They also obviate those unpleasant accidents that involve broken glass to be removed from one's pockets and the trickling of preserving fluid down one's leg.

APPENDIX B-4-3: WINTER WILDLIFE DATA COLLECTION FORM

OWMC PHASE 4B BIOLOGY

DATE:______________ TIME:______ SITE:________ SITE VIC.:_______

OBSERVER(S) ____________________ WEATHER: ______________________

SPECIES	STATION #											TOTAL

Page __ of __

APPENDIX B-4-4: BREEDING BIRD DATA COLLECTION FORM

OWMC PHASE 4B BIOLOGY

DATE: TIME: OBSERVER(S)

WEATHER: SITE: SITE VICINITY:

Transect #	Quadrat #	Species	Singing Male	Non-Singing Male	Female	Juvenal	Unknown	Miscellaneous Remarks

HABITAT DESCRIPTION:

APPENDIX B-4-5: MAMMAL TRAPPING DATA COLLECTION FORM

MAMMAL CATALOGUE

ROYAL ONTARIO MUSEUM

Year ....

Collectors: ....

General Area: ....

Page:

Museum Number	Field No.	Species	Sex	TL	TV	HF	Ear	FA	WS	WT	Locality	Date	Remarks

APPENDIX B-4-6: REPTILE AND AMPHIBIAN DATA COLLECTION FORM

DATE:____________________ TIME:______________ OBSERVER(S)__________

WEATHER:__________________SITE:_____________SITE VICINITY:__________

Station #	Species	# of Individuals	Behaviour	Habitat	Collected	Collection #

Terrestrial Habitat:

Aquatic Habitat:

APPENDIX B-4-7: BUTTERFLY DATA COLLECTION FORM

DATE:____________________ TIME:______________ OBSERVER(S)____________

WEATHER:__________________ SITE:______________ SITE VICINITY:____________

Station #	Species	# of Individuals	Behaviour	Habitat	Collected	Collection #

APPENDIX B-4-8: GILL NET CATCH RECORD

Sample station GLAL____________________Sample No. GLAL________

Date Set _____________________________Time ________________

Netting time ______________________Depth of set_______________

Nets used 1.5 2.0 2.5 3.0 3.4 4.0 4.5 5.0 mesh size

(inches)

Species ____

APPENDIX B-4-9: FISHERIES FIELD COLLECTION DATA SHEET

GARTNER LEE ASSOCIATES LIMITED CLIENT: OWMC

Name: ____________ Coll.No. ______ Stat. No. ______
Waterbody ____________ GLAL ______
Locality of Waterbody ____________
____
Locality of Station ____________
____
Lat. ______ N Long. ______ S Date ___ D ___ M ___ Y ___
Time Started ______ hrs. Duration ______ hrs.
Water Type ______ Stream ______ River ______ Flooded Area ______ Pool ______
Other ____________
Water Temperature ______ C Air Temperature ______
Distance Offshore Min ______ m/cm Max ______ m/cm
Depth Capture ______ Max ______ Min ______
Plant Type
Submergent ______ Floating ______ Emergent ______ None ______
Other ____________
Bottom Type
Clay/ ______ Muck/ ______ Detritus/ ______ Sand/ ______ Silt ______
Rubble/ ______ Rock/ ______ Other ______
Current
Still ___ Slow ___ Medium ___ Fast ___ Quantitative ______ m/s
Water Colour
Colourless ______ Turbid ______ Other ______
Cover (shore) None ___ Sparse ___ Moderate ___ Dense ______
Other ____________
Gear
Seine ______ Gill Net ______ Trawl ______ Electrofish ______
Minnow trap ______ Dip Net ______ Other ______
Mesh Size ______ Length/width ______
Selectivity of Sample
all kept sample ______ selected ______ no catch ______ none kept ______
Preservative
formalin ______ Frozen ______ Alcohol ______
Collector's Name ____________
____
Sample Data Other
____
____
____
____
____
____
____
____
____

APPENDIX B-4-10: FISH SAMPLING METHOD AND EQUIPMENT

Gill nets and minnow traps were used in this study.

The following descriptions of fish sampling equipment and methods have been adapted, from the Ontario Ministry of Natural Resources' Manual of Instructions Aquatic Habitat Inventory Surveys (Dodge et al. 1985).

Gill Net

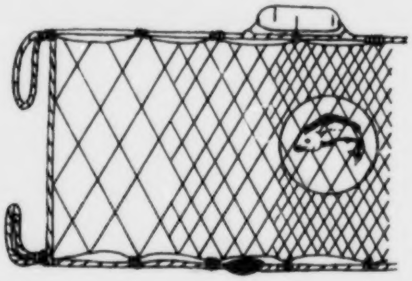


FIGURE B-4-1: GILL NET
Source: Dodge et al. (1985)

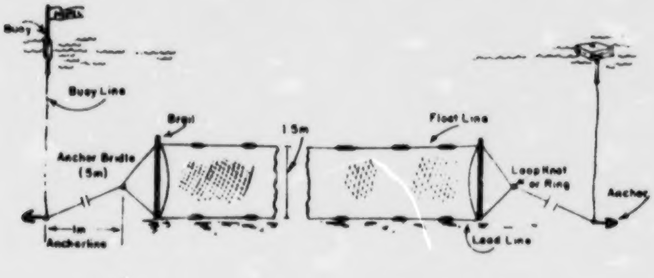
Gangs of monofilament gill nets were used for sampling larger fish in the Welland River. The gang of nets consisited of eight different stretched mesh size segments, each 2.1 m in depth and 15 m in length.

The gangs of nets were assembled by tying them together. The randomized mesh size distribution, depending on the number of segments of net, was:

mm	64	114	38	89	51	1-2	76	127
in.	2.5	4.5	1.5	3.5	2.0	4.0	3.0	5.0

Each gang of gill nets was rigged with a buoy to clearly indicate its presence to passing boaters.

A typical gill net set is shown in the diagram below:



Gill nets were set from shallow water to deep water and in such a manner that the float line rested at least 1 m below the surface of the water.

To set the net from a boat (propelled backwards by a 6 horsepower outboard engine) the net man positioned himself in the bow and carried out the following procedures.

1) Secured the anchor line to some immovable object (E.G., a tree) on shore and played out the net.

2) Played out the float and weighted lead lines evenly with the float line handled at the higher level and toward the water. If the net was not tangled, it was often possible to handle the float line only, allowing the lead line to run while 'shaking-out' the netting. If tangled, it was necessary to stretch the float and lead lines further apart.

(3) Lowered the anchor line to the bottom when the net was fully played out and drawn taut.

4) Applied more tautness or tension by jerking the buoy line and bouncing the anchor along the bottom, outwardly from the net terminal.

To lift the net, the net man, as the outboard engine operator controlled the boat's movement, carried out the followng procedures:

1) Lifted the downward buoy and anchor into the boat.

2) Detached the buoy and anchor line rigging from the net while retaining hold of the float and lead lines.

3) Grasped the terminals of the float and lead line in one hand and pulled the net into the boat as the other partially closed hand is slid down the net, to arm's length. This method is often referred to as the 'rope-type fashion'.

4) Pulled in the net by alternating position and function of the hands.

5) Coiled the net with care, to prevent tangling, into the net container.

6) Removed fish as the net is retrieved and placed them in the bottom of the boat.

7) Rinsed slime and disengaged tangles from the net after removing fish and before coiling is continued.

8) Detached second rigging from net.

9) Tied float and lead line terminals to handle on net container.

Minnow Trap A minnow trap such as the one illustrated below was used. It is a two-sectioned unit of wire mesh with small throat openings at either end and which lock together to form a trap. The traps were baited with bread, set in the centre of the creek and secured to the top of the overhanging culvert.

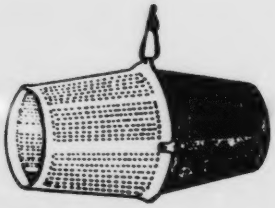


FIGURE B-4-2: **MINNOW TRAP**

Source: Dodge *et al*. (1985)

APPENDIX C

LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

APPENDIX C : LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

SCIENTIFIC NAME	COMMON NAME	SITE PHASE 4A	SITE PHASE 4B	SITE VICINITY PHASE 4A	SITE VICINITY PHASE 4B
EQUISETACEAE	HORSETAIL FAMILY				
Equisetum arvense L.	Field Horsetail	x	x		
E. sylvaticum L.	Wood Horsetail	x	x		x
OPHIOGLOSSACEAE	ADDER'S - TONGUE FAMILY				
Botrychium dissectum Spreng. var. dissectum	Dissected Grape Fern	x			x
B. multifidum (Gmel.) Rupr. var. intermedium (D.C. Eat.) Farw.	Intermediate Leather Grape Fern				x
B. virginianum (L.) Sw.	Rattlesnake Fern		x		x
OSMUNDACEAE	ROYAL FERN FAMILY				
Osmunda cinnamomea L.	Cinnamon Fern	x			x
O. regalis L.	Royal Fern	x			x
DENNSTAEDTIACEAE	BRACKEN FAMILY				
Pteridium aquilinum (L.) Kuhn	Bracken Fern	x	x		x
ASPLENIACEAE	SPLEENWORT FAMILY				
Onoclea sensibilis L.	Sensitive Fern	x	x		x
Athyrium felix-femina L.	Lady Fern	x	x		x
Dryopteris marginalis (L.) A. Gray	Evergreen Wood-fern		x		x
D. spinulosa Muell. Kuntze	Spinulose Shield-fern	x			
Polystichum acrostichoides (Michx.) Schott	Christmas Fern		x		x
THELYPTERIDACEAE	BEECH FERN FAMILY				
Thelypteris palustris (Salisb.) Schott	Marsh Fern	x	x		x
PINACEAE	PINE FAMILY				
Pinus strobus L.	White Pine	x	x	x	x
Picea glauca (Moench) Voss.	White Spruce			x	
Tsuga canadensis	Eastern Hemlock			x	

APPENDIX C : LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
(L.) Carr.					
TYPHACEAE	CATTAIL FAMILY				
Typha angustifolia L.	Narrow-leaved Cattail		x		x
T. latifolia L.	Cattail	x	x		x
SPARGANIACEAE	BUR-REED FAMILY				
Sparganium eurycarpum Engelm.	Broad-fruited Bur-reed		x		x
ALISMATACEAE	WATER-PLANTAIN FAMILY				
Alisma plantago-aquatica L.	Water-plantain	x	x		x
Sapittaria latifolia Willd.	Arrowhead	x			
POACEAE	GRASS FAMILY				
Bromus inermis Leyss.	Smooth Brome Grass	x	x		x
B. japonicus Thun. ex Murray	Japanese Brome	x			
Festuca obtusa Biehl.	Nodding Fescue	x			x
F. pratensis Huds.	Meadow Fescue	x			
Glyceria grandis S. Wats.	Tall Manna-grass				x
Glyceria septentrionalis A.S. Hitchc.	Eastern Manna Grass	x			
G. striata (Lam.) A.S. Hitchc.	Fowl Manna Grass	x	x		x
Poa compressa L.	Canada Blue Grass	x	x		x
P. palustris L.	Fowl Meadow Grass	x			
P. pratensis L.	Kentucky Blue Grass	x	x		x
Dactylis glomerata L.	Orchard Grass		x		x
Phragmites australis (Cav.) Trin. ex Steudel	Common Reed		x		
Schizachne purpurascens (Torrey) Swallen	Purple Melic Grass	x			x
Agropyron repens (L.) Beauv.	Quack Grass	x	x		x
Secale cereale L.	Rye	x			
Elymus hystrix L.	Bottle-brush Grass	x			
Hordeum jubatum L.	Squirrel-tail Grass		x		
Avena sativa L.	Oats		x		
Dathonia spicata (L.) Beauv.	Poverty Oat Grass	x	x		x

APPENDIX C : LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

SCIENTIFIC NAME	COMMON NAME	SITE PHASE 4A	SITE PHASE 4B	SITE VICINITY PHASE 4A	SITE VICINITY PHASE 4B
Calamagrostis canadensis (Michx.) Beauv.	Canada Blue-joint	x			
Agrostis gigantea Roth	Redtop	x	x		
A. perennans (Walt.) Tuckerm.	Autumn Bent Grass	x			
A. scabra Willd.	Rough Hair Grass	x	x		
Cinna arundinacea L.	Stout Wood Grass	x	x		x
Phleum pratense L.	Timothy	x	x		x
Brachyelytrum erectum (Schreb.) Beauv.	Bearded Short-husk		x		x
Milium effusum L.	Wood Millet	x			
Oryzopsis asperifolia Michx.	Rough-leaved Mountain Rice	x	x		x
Phalaris arundinacea L.	Reed Canary Grass		x		x
Leersia oryzoides (L.) Sw.	Rice Cut Grass	x	x		x
Panicum capillare L.	Common Witch Grass				x
Echinochloa crusgalli (L.) Beauv.	Barnyard Grass	x	x		
Setaria viridis (L.) Beauv.	Green Foxtail		x		x
CYPERACEAE	SEDGE FAMILY				
Scirpus acutus Muchl.	Hard-stemmed Bulrush				
S. cyperinus (L.) Kunth.	Wool-grass	x	x		x
S. validus Vahl.	American Great Bulrush		x		x
Eleocharis ovata Roth R.& S.	Ovoid Spike Rush	x	x		
Carex albursina Scheld	Sedge	x			
C. arctata Boott.	Sedge	x			
C. blanda Dew.	Sedge		x		x
C. bromoides Schk.	Sedge		x		
C. brunnescens	Sedge		x		
(Pers.) Poir.	Sedge				
C. convoluta Mack.	Sedge	x			x
C. crinita Lam.	Sedge	x	x		
C. deweyana Schw.	Sedge	x			
C. gracillima Schw.	Sedge	x	x		x
C. interior Bailey	Sedge		x		x
C. intumescens Rudge	Sedge	x	x		x
C. lacustris Willd.	Sedge	x			
C. laxiculmis Schw.	Sedge				x
C. laxiflora Lam.	Sedge		x		
C. lupulina Muhl. ex Willd.	Sedge	x	x		x
C. lurida Wahl.	Sedge	x	x		

APPENDIX C : LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
C. pedunculata Muhl.	Sedge		x		x
C. pensylvanica Lam	Sedge	x	x		x
C. platyphylla Carey	Sedge	x	x		x
C. projecta Mack.	Sedge	x	x		
C. rosea Schk.	Sedge	x	x		x
C. scoparia Muhl. ex Willd	Sedge	x	x		
C. stipata Muhl.	Sedge	x	x		
C. tenera Dew.	Sedge				x
C. tribuloides Wahl.	Sedge	x	x		
C. vulpinoidea Michx.	Sedge	x	x		x
C. woodii Dew.	Sedge		x		
ARACEAE	**ARUM FAMILY**				
Arisaema triphyllum (L.) Torr.	Jack-in-the-pulpit	x	x		x
LEMNACEAE	**DUCKWEED FAMILY**				
Lemna minor L.	Common Duckweed	x	x		x
L. trisulca L.	Star Duckweed		x		
JUNCACEAE	**RUSH FAMILY**				
Juncus dudleyi Wiegand.	Dudley's Rush	x			
J. effusus L.	Soft Rush	x	x		x
J. tennuis Willd.	Path Rush	x	x		x
J. torreyi Coville	Torrey's Rush	x			
Luzula acuminata Raf.	Hairy Wood Rush	x			x
LILIACEAE	**LILY FAMILY**				
Uvularia sessilifolia L.	Sessile-leaved Bellwort	x	x		x
Hemerocallis fulva L.	Day Lily		x		
Allium tricoccum Ait.	Wild Leek	x			
Lilium canadense var. michiganense Farw.	Michigan Lily	x	x		x
Erythronium americanum Ker.	Yellow Trout Lily	x	x		x
Smilacena racemosa (L.) Desf.	False Solomon's-seal	x	x		x
S. stellata Desf.	Star-flowered Solomon's-seal		x		x

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SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
Maianthemum canadense Desf.	Wild Lily-of-the-valley	x	x		x
Streptopus roseus Michx.	Sessile-leaved Twisted Stalk		x		
Polygonatum pubescens (Willd.) Pursh.	Solomon's-seal	x	x		x
Medeola virginiana L.	Indian Cucumber-root				x
Trillium erectum L.	Red Trillium				x
T. grandiflorum (Michx.) Salisb.	Large-flowered Trillium	x	x		x
Smilax herbacea L.	Carrionflower	x	x		x
S. tamnoides L. var. hispida (Muhl.) Fern.	Bristly Catbrier	x	x		x
IRIDACEAE	IRIS FAMILY				
Iris versicolor L.	Wild Blue Flag	x	x		x
ORCHIDACEAE	ORCHID FAMILY				
Habenaria lacera (Michx.) Lodd.	Ragged-fringed Orchid		x		
Epipactis helleborine (L.) Crantz.	Helleborine	x	x		x
Corallorhiza maculata Raf.	Large Coral-root				x
SALICACEAE	WILLOW FAMILY				
Populus grandidentata Michx.	Large-toothed Aspen	x	x	x	x
P. tremuloides Michx.	Trembling Aspen	x	x	x	x
Salix alba L.	White Willow	x			
S. amygdaloides Anderss.	Peach-leaved Willow	x	x		
S. bebbiana Sarg.	Bebb's Willow		x		
S. eriocephala Michx.	Willow	x			
S. fragilis L.	Crack Willow	x			
S. lucida Muhl.	Shining Willow	x			
S. nigra Marsh.	Black Willow	x	x	x	x
S. petiolaris Sm.	Slender Willow	x	x		
JUGLANDACEAE	WALNUT FAMILY				
Juglans nigra L.	Black Walnut	x			x
Carya cordiformis (Wang.) K. Koch	Bitternut Hickory			x	

APPENDIX C : LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
C. ovata (Mill.) K. Koch.	Shagbark Hickory	x	x	x	x
BETULACEAE	BIRCH FAMILY				
Carpinus caroliniana Walt.	Blue Beech	x	x	x	x
Ostrya virginiana (Mill.) K. Koch	Hop Hornbeam	x	x	x	x
Betula alleghenienisis Britt.	Yellow Birch			x	
B. papyrifera Marsh.	Paper Birch			x	x
Alnus incana (L.) Moench ssp. rugosa (Du Roi) Clausen	Speckled Alder				x
FAGACEAE	BEECH FAMILY				
Fagus grandifolia Ehrh.	American Beech	x	x	x	x
Quercus alba L.	White Oak	x	x	x	x
Q. bicolor Willd.	Swamp White Oak	x	x	x	x
Q. palustris Muenchh.	Pin Oak	x	x		
Q. rubra L.	Red Oak	x	x	x	x
ULMACEAE	ELM FAMILY				
Ulmus americana L.	American Elm	x	x	x	x
U. rubra Muhl.	Slippery Elm			x	
URTICACEAE	NETTLE FAMILY				
Urtica dioica L.	Stinging Nettle				x
Laportea canadensis (L.) Wedd.	Wood Nettle	x			
Pilea pumila (L.) Gray	Clearweed	x	x		x
Boehmeria cylindrica (L.) Schwein.	False Nettle	x	x		x
SANTALACEAE	SANDALWOOD FAMILY				
Comandra umbellata (L.) Nutt.	Bastard Toadflax	x	x		x

APPENDIX C : LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
ARISTOLOCHIACEAE	BIRTHWORT FAMILY				
Asarum canadense L.	Wild Ginger	x			
POLYGONACEAE	BUTTERCUP FAMILY				
Rumex acetosella L.	Sheep Sorrel		x		x
Rumex crispus L.	Curled Dock	x	x		x
Polygonum coccineum Muhl.	Swamp Smartweed	x			
P. hydropiperoides Michx.	Mild Water Pepper	x			
P. pensylvanicum L.	Pennsylvania Smartweed	x	x		
P. persicaria L.	Lady's Thumb		x		
P. sagittatum L.	Arrow-leaved Smartweed				x
Tovara virginiana (L.) Raf.	Virginia Knotweed	x			
Bilderdykia convolvulus (L.) Dumort.	Wild Buckwheat	x			
Fagopyrum esculentum Moench.	Buckwheat	x			
CHENOPODIACEAE	SPINACH FAMILY				
Chenopodium album L.	Lamb's-quarters	x	x		
Atriplex hastata L.	Halberd-leaved Orache	x			
AMARANTHACEAE	AMARANTH FAMILY				
Amaranthus retroflexus L.	Green Amaranth		x		
PHYTOLACCACEAE	POKEWEED FAMILY				
Phytolacca americana L.	Pokeweed	x			
PORTULACACEAE	PURSLANE FAMILY				
Claytonia virginica L.	Spring Beauty		x		x
CARYOPHYLLACEAE	PINK FAMILY				
Stellaria graminea L.	Grass-leaved Stitchwort	x	x		
S. longifolia Willd.	Long-leaved Stitchwort				x
Cerastium vulgatum L.	Larger Mouse-ear Chickweed		x		x
Arenaria lateriflora L.	Blunt-leaved Sandwort	x			
A. serpyllifolia L.	Thyme-leaved Sandwort	x			

APPENDIX C : LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
Dianthus armeria L.	Deptford Pink	x	x		x
RANUNCULACEAE	BUTTERCUP FAMILY				
Caltha palustris L.	Marsh-marigold				x
Coptis groenlandica (Oeder.) Fern.	Goldthread	x			x
Actaea rubra (Ait.) Willd.	Red Baneberry				x
Aquilegia canadensis L.	Wild Columbine	x			
Anemone quinquefolia L.	Snow-drops		x		x
Hepatica americana (DC.) Ker.	Blunt-leaved Hepatica	x	x		x
Clematis virginiana L.	Virgin's Bower	x			
Ranunculus abortivus L.	Kidney-leaved Buttercup	x	x		x
R. acris L.	Tall Buttercup	x			
R. pensylvanicus L.f.	Bristly Crowfoot	x	x		
R. scleratus L.	Celery-leaved Buttercup	x	x		
Thalictrum dioicum L.	Early Meadow Rue	x			
T. polygamum Muhl.	Tall Meadow Rue	x			
BERBERIDACEAE	BARBERRY FAMILY				
Podophyllum peltatum L.	May-apple	x	x		x
Berberis thunbergii DC.	Japanese Barberry	x			x
LAURACEAE	LAUREL FAMILY				
Sassafras albidum (Nutt.) Nees	Sassafras			x	
PAPAVERACEAE	POPPY FAMILY				
Sanguinaria canadensis L.	Bloodroot	x			
Chelidonium majus L.	Celandine				x
BRASSICACEAE	MUSTARD FAMILY				
Lepidium virginicum L.	Wild Peppergrass		x		x
Thlaspi arvense L.	Field Pennycress		x		
Alliaria alliaria (L.) Britton.	Garlic Mustard				x
Cardamine douglassii (Torr.) Britton.	Purple Cress		x		x
Capsella bursa-pastoris Medic.	Shepherd's Purse		x		
Hesperis matronalis L.	Dame's Rocket				x

APPENDIX C : LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

SCIENTIFIC NAME	COMMON NAME	SITE PHASE 4A	SITE PHASE 4B	SITE VICINITY PHASE 4A	SITE VICINITY PHASE 4B
CRASSULACEAE	SEDUM FAMILY				
Penthorum sedoides L.	Ditch-stonecrop	x			
SAXIFRAGACEAE	SAXIFRAGE FAMILY				
Tiarella cordifolia L.	False Mitrewort		x		x
Mitella diphylla L.	Mitrewort				x
GROSSULARIACEAE	GOOSEBERRY FAMILY				
Ribes americanum Mill.	American Black Currant	x	x		x
R. cynosbati L.	Pasture Gooseberry	x	x		
HAMAMELIDACEAE	WITCH-HAZEL FAMILY				
Hamamelis virginiana L.	Witch-hazel	x	x	x	x
ROSACEAE	ROSE FAMILY				
Spirea alba Du Roi	Narrow-leaved Meadowsweet	x	x		x
Pyrus communis L.	Pear	x	x		x
Malus domestica Borkh.	Apple	x	x		x
Amelanchier arborea (Michx. fil.) Fern.	Serviceberry	x	x		x
A. humilis Wieg.	Serviceberry	x			
A. laevis Wieg.	Smooth Serviceberry	x			x
Aronia melanocarpa (Michx.) Ell.	Chokeberry	x			x
Crataegus calpodendron (Ehrh.) Medik.	Hawthorn	x			
C. coccinea L.	Hawthorn		x		x
C. crus-galli L.	Cockspur thorn				x
C. flabellata (Spach) Kirchn.	Hawthorn		x		x
C. monogyna Jacq.	English Hawthorn				x
C. punctata Jacq.	Hawthorn				x
Rubus allegheniensis Porter	Common Blackberry	x	x		x
R. flagellaris Willd.	Northern Dewberry	x			x
R. hispidus L.	Dewberry	x	x		x
R. idaeus L. var. strigosus (Michx.) Maxim.	Wild Red Raspberry	x	x		x
R. occidentalis L.	Black Raspberry	x			

APPENDIX C : LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
R. pubescens Raf.	Dwarf Raspberry	x	x		x
Fragaria vesca L.	Wood Strawberry	x	x		x
F. virginiana Dene.	Strawberry	x	x		x
Potentilla norvegica L.	Rough Cinquefoil	x	x		x
P. recta L.	Sulphur Cinquefoil	x	x		x
P. simplex Michx.	Common Cinquefoil	x	x		x
Waldsteinia fragarioides (Michx.) Tratt	Barren Strawberry		x		
Geum allepicum Jacq. var. strictum (Ait.) Fern	Yellow Avens	x	x		
G. canadense Jacq.	Avens	x			x
G. virginianum L.	Rough Avens	x	x		x
Agrimonia gryposepala Wallr.	Agrimony	x	x		x
Rosa blanda Ait.	Smooth Rose	x	x		x
R. carolina L.	Pasture Rose	x	x		
R. eglanteria L.	Sweetbriar	x			x
R. palustris Marsh.	Swamp Rose	x	x		x
Prunus avium L.	Sweet Cherry	x			
P. nigra Ait.	Canada Plum				x
P. pensylvanica L.fil.	Pincherry		x	x	
P. serotina Ehrh.	Black Cherry	x	x	x	x
P. virginiana L.	Choke Cherry	x	x	x	x
FABACEAE	PEA FAMILY				
Gleditsia triacanthos. L.	Honey Locust		x		
Medicago lupulina L.	Black Medic		x		x
M. sativa L.	Alfalfa	x	x		x
Melilotus alba Desr.	White Sweet-clover	x	x		
M. officinalis (L.) Lam.	Yellow Sweet-clover	x			
Trifolium hybridum L.	Alsike Clover	x			
T. pratense L.	Red Clover	x	x		x
T. repens L.	White Clover	x			
Lotus corniculatus L.	Bird's-foot Trefoil	x	x		
Coronilla varia L.	Crown Vetch		x		
Desmodium glutinosum (Muhl.) Wood	Tick-trefoil				x
Vicia cracca L.	Cow Vetch	x	x		x
Amphicarpa bracteata (L.) Fern.	Hog-peanut	x	x		x
Apios americana Medic.	Groundnut	x			

APPENDIX C : LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

SCIENTIFIC NAME	COMMON NAME	SITE PHASE 4A	SITE PHASE 4B	SITE VICINITY PHASE 4A	SITE VICINITY PHASE 4B
GERANIACEAE	GERANIUM FAMILY				
Geranium maculatum L.	Wild Geranium	x	x		x
G. robertianum L.	Herb-robert		x		x
OXYLIDACEAE	WOOD-SORREL FAMILY				
Oxalis stricta L.	European Wood Sorrel	x	x		x
EUPHORBIACEAE	SPURGE FAMILY				
Acalypha paucifolia Willd.	Three-seeded Mercury	x			
ANACARDIACEAE	CASHEW FAMILY				
Rhus radicans L.	Poison Ivy	x	x		x
R. typhina L.	Staghorn Sumac	x			x
AQUIFOLIACEAE	HOLLY FAMILY				
Ilex verticillata (L.) Gray	Winterberry	x	x		x
CELASTRACEAE	STAFF-TREE FAMILY				
Euonymus obovatus Nutt.	Running Strawberry Bush	x	x		x
Celastrus scandens L.	Bittersweet	x			
ACERACEAE	MAPLE FAMILY				
Acer negundo L.	Manitoba Maple	x			
A. nigrum Michx. f.	Black Maple			x	
A. rubrum L.	Red Maple	x	x	x	x
A. saccharinum L.	Silver Maple	x	x	x	x
A. saccharum Marsh.	Sugar Maple	x	x	x	x
BALSAMINACEAE	JEWEL-WEED FAMILY				
Impatiens capensis Meerb.	Spotted Jewelweed	x	x		x
RHAMNACEAE	BUCKTHORN FAMILY				
Rhamnus alnifolia L'Her.	Alder-leaved Buckthorn		x		x

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SCIENTIFIC NAME	COMMON NAME	SITE PHASE 4A	SITE PHASE 4B	SITE VICINITY PHASE 4A	SITE VICINITY PHASE 4B
VITACEAE	GRAPE FAMILY				
Vitis riparia Michx.	Wild Grape	x	x		x
Parthenocissus quinquefolia (L.) Planch.	Virginia Creeper	x			
P. vitacea (Knerr.) Hitchc.	Virginia Creeper	x	x		x
TILIACEAE	LINDEN FAMILY				
Tilia americana L.	Basswood	x	x	x	x
HYPERICACEAE	ST. JOHN'S-WORT FAMILY				
Hypericum kalmianum L.	Kalm's St.John's-wort				
H. perforatum L.	Common St. John's-wort	x	x		x
H. punctatum Lam.	Spotted St. John's-wort		x		
Triadenum fraseri (Spach.) Gl.	Marsh St. John's-wort	x	x		x
VIOLACEAE	VIOLET FAMILY				
Viola affinis LeConte.	LeConte's Violet				x
V. blanda Willd.	Sweet White Violet				x
V. conspersa Reichenb.	Dog Violet		x		x
V. cucullata Ait.	Stemless Blue Violet	x			x
V. incognita Brainerd.	Large-leaved White Violet				x
V. pallens (Banks.) Brainerd.	Northern White Violet				x
V. papilionacea Pursh.	Meadow Blue Violet				x
V. pubescens Ait. var. pubescens	Downy Yellow Violet	x	x		x
V. rostrata Pursh.	Long-spurred Violet				x
V. selkirkii Pursh.	Great-spurred Violet		x		
V. septentrionalis Greene.	Northern Blue Violet		x		x
V. sororia Willd.	Woolly Blue Violet		x		
NYSSACEAE	SOUR GUM FAMILY				
Nyssa sylvatica Marsh	Black Gum	x	x	x	x
ONAGRACEAE	EVENING-PRIMROSE FAMILY				
Epilobium ciliatum Raf.	Northern Willow-herb	x	x		x
Oenothera parviflora L.	Small-flowered Evening-primrose	x			

APPENDIX C : LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

SCIENTIFIC NAME	COMMON NAME	SITE		SITE VICINITY	
		PHASE		PHASE	
		4A	4B	4A	4B
Circaea quadrisulcata (Maxim.) Franch. & Sav.	Enchanter's Nightshade	x	x		x
ARALIACEAE	GINSENG FAMILY				
Aralia nudicaulis L.	Wild Sarsaparilla	x	x		x
A. racemosa L.	Spikenard	x			
Panax trifolium L.	Dwarf Ginseng				x
APIACEAE	CARROT FAMILY				
Sanicula gregaria Bicknell.	Clustered Snakeroot		x		x
S. marilandica L.	Black Snakeroot	x	x		x
Osmorhiza claytoni (Michx.) Clarke	Hairy Sweet-cicely				
O. longistylis (Torr.) DC.	Smoother Sweet-cicely		x		x
Cicuta bulbifera L.	Bulbous Water-hemlock	x			
C. maculata L.	Spotted Water-hemlock	x	x		x
Cryptotaenia canadensis (L.) DC.	Honewort				x
Heracleum lanatum Michx.	Cow-parsnip		x		x
Daucus carota L.	Wild Carrot	x	x		x
CORNACEAE	DOGWOOD FAMILY				
Cornus florida L.	Flowering Dogwood			x	x
C. obliqua Raf.	Silky Dogwood	x	x		x
C. racemosa Lam.	Gray Dogwood	x	x		
C. stolonifera Michx.	Red Osier	x			x
PYROLACEAE	WINTERGREEN FAMILY				
Monotropa uniflora (L.) Gray	Indian-pipe	x	x		x
ERICACEAE	HEATH FAMILY				
Gaultheria procumbens L.	Wintergreen	x			x
Vaccinium angustifolium Ait.	Low Sweet Blueberry		x		x
V. corymbosum L.	High-bush Blueberry	x	x		x
V. myrtilloides Michx.	Velvet-leaf Blueberry		x		
V. pallidum Ait.	Dryland Blueberry	x	x		

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SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
PRIMULACEAE	PRIMROSE FAMILY				
Lysimachia ciliata L.	Fringed Loosestrife	x	x		
L. thyrsiflora L.	Tufted Loosestrife	x	x		x
Trientalis borealis Raf.	Star-flower	x	x		x
OLEACEAE	OLIVE FAMILY				
Fraxinus americana L.	White Ash	x	x	x	x
F. nigra Marsh.	Black Ash	x		x	x
F. pennsylvanica Marsh.	Red Ash	x		x	
F. pennsylvanica var. subintegerrima (Vahl) Fern.	Green Ash			x	
APOCYNACEAE	DOGBANE FAMILY				
Apocynum androsaemifolium L.	Spreading Dogbane	x	x		
ASCLEPIADACEAE	MILKWEED FAMILY				
Asclepias incarnata L.	Swamp Milkweed	x	x	x	x
A. syriaca L.	Common Milkweed	x	x	x	x
CONVOLVULACEAE	MORNING-GLORY FAMILY				
Convolvulus arvensis L.	Small Bindweed		x		
POLEMONIACEAE	PHLOX FAMILY				
Phlox divaricata L.	Wild Blue Phlox				x
HYDROPHYLLACEAE	WATERLEAF FAMILY				
Hydrophyllum virginianum L.	Virginia Waterleaf	x	x		
BORAGINACEAE	BORAGE FAMILY				
Myosotis laxa Lehm.	Smaller Forget-me-not		x		
Echium vulgare L.	Viper's Bugloss		x		x

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SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
VERBENACEAE	VERVAIN FAMILY				
Verbena hastata L.	Blue Vervain	x	x		x
LAMIACEAE	MINT FAMILY				
Scutellaria lateriflora L.	Mad-dog Skullcap	x			
Prunella vulgaris L.	Heal-all	x	x		x
Hedeoma pulegioides L.	American Pennyroyal	x			
Satureja vulgaris (L). Fritsch.	Wild Basil		x		x
Lycopus americanus Muhl.	American Water-horehound	x	x		x
L. uniflorus Michx.	Water-horehound	x	x		x
L. virginicus L.	Water-horehound		x		
Collinsonia canadensis L.	Horse-balm	x			
SOLANACEAE	NIGHTSHADE FAMILY				
Solanum dulcamara L.	Climbing Nightshade	x	x		x
SCROPHULARIACEAE	FIGWORT FAMILY				
Verbascum thapsus L.	Common Mullein	x	x		x
Chelone glabra L.	Turtlehead	x			
Veronica officinalis L.	Common Speedwell	x			x
V. scutellata L.	Marsh Speedwell	x			
Pedicularis canadensis L.	Lousewort	x			
OROBANCHACEAE	BROOM-RAPE FAMILY				
Conopholis americana (L.f.) Wallr.	Squaw-root				x
Epifagus virginiana (L.) Bart.	Beech-drops	x			x
BIGNONIACEAE	TRUMPET-CREEPER FAMILY				
Catalpa speciosa Warder	Catalpa				x
PLANTAGINACEAE	PLANTAIN FAMILY				
Plantago lanceolata L.	Narrow-leaved Plantain	x			
P. major L.	Common Plantain		x		x
P. rugelii Dene.	Rugel's Plantain	x			

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SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
RUBIACEAE	MADDER FAMILY				
Cephalanthus occidentalis L.	Buttonbush	x	x	x	
Mitchella repens L.	Partridge-berry	x			
Galium aparine L.	Cleavers		x		x
G. asprellum Michx.	Rough Bedstraw		x		
G. boreale L.	Northern Bedstraw				x
G. circaezans Michx.	Wild Licorice				x
G. lanceolatum Torr.	Wild Licorice				x
G. obtusum Bigel.	Bedstraw	x			
G. palustre L.	Marsh Bedstraw				x
G. trifidum L.	Small Bedstraw		x		
G. triflorum Michx.	Sweet-scented Bedstraw	x			x
CAPRIFOLIACEAE	HONEYSUCKLE FAMILY				
Sambucus canadensis L.	Common Elder	x	x		x
Viburnum acerifolium L.	Maple-leaved Viburnum	x	x	x	x
V. cassinoides L.	Wild Raisin				x
V. lentago L.	Nannyberry		x		x
V. rafinesquianum Schult.	Downy Arrow-wood		x		x
V. recognitum Fern.	Southern Arrow-wood	x	x		x
Triosteum aurantiacum Bick.	Horse-gentian	x	x		x
Lonicera canadensis Bartr.	Fly Honeysuckle	x			
L. dioica L.	Glaucous Honeysuckle	x	x		x
Diervilla lonicera Mill.	Bush Honeysuckle	x			x
DIPSACACEAE	TEASEL FAMILY				
Dipsacus sylvestris Huds.	Wild Teasel	x	x		x
CUCURBITACEAE	GOURD FAMILY				
Echinocystis lobata (Michx.) T. & G.	Wild Cucumber	x			x
CAMPANULACEAE	HAREBELL FAMILY				
Lobelia inflata L.	Indian Tobacco	x			x

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SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
ASTERACEAE	ASTER FAMILY				
Eupatorium maculatum L.	Spotted Joe-pye Weed		x		
E. perfoliatum L.	Boneset	x			
E. rugosum Houtt.	White Snakeroot		x		
Solidago altissima L.	Late Goldenrod		x		x
S. bicolor L.	Silverrod	x	x		x
S. caesia L.	Blue-stemmed Goldenrod	x	x		
S. canadensis L.	Canada Goldenrod	x	x		x
S. flexicaulis L.	Zig-zag Goldenrod	x			
S. gigantea Ait.	Tall Goldenrod		x		x
S. juncea Ait.	Early Goldenrod	x			
S. rugosa Mill.	Rough-stemmed Goldenrod	x	x		x
Euthamia graminifolia (L.) Nutt.	Grass-leaved Goldenrod	x	x		x
Aster cordifolius L.	Common Blue Wood Aster		x		
A. ericoides L.	White Heath Aster	x			
A. lateriflorus (L.) Britt.	One-sided Aster	x			
A. macrophyllus L.	Large-leaved Aster	x	x		x
A. novae-angliae L.	New England Aster	x	x		x
A. pilosus Willd.	Spray Aster	x	x		
A. puniceus L.	Purple-stemmed Aster		x		
A. simplex Willd.	Panicled Aster	x			
A. umbellatus Mill.	Flat-topped White Aster	x	x		x
Erigeron annuus (L.) Pers.	White Top	x	x		x
E. philadelphicus L.	Philadelphia Fleabane				x
Antennaria neglecta Greene	Pussytoes	x			
Ambrosia artemisiifolia L.	Common Ragweed	x	x		x
Rudbeckia hirta L.	Black Eyed Susan				x
Bidens cernua L.	Nodding Beggar-ticks	x			
B. connata Muhl.	Devil's Beggar-ticks	x	x		x
B. frondosa L.	Beggar-ticks	x	x		
Achillea millefolium L.	Yarrow	x	x		x
Chrysanthemum leucanthemum L.	Ox-eye Daisy		x		x
Tussilago farfara L.	Coltsfoot	x			
Senecio vulgaris L.	Common Groundsel	x			
Arctium minus Schk.	Common Burdock				x
Carduus nutans L.	Musk Thistle				x
Cirsium arvense (L.) Scop.	Canada Thistle	x	x		x
C. vulgare (Savi.) Tenore	Bull Thistle	x			

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SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
Centauria maculosa Lam.	Spotted Knapweed		x		x
Cichorium intybus L.	Chickory	x	x		x
Taraxacum officinale Weber	Dandelion	x	x		x
Sonchus arvensis L.	Corn Sow-Thistle		x		x
Lactuca biennis (Moench) Fern.	Tall Blue Lettuce	x			
L. scariola L.	Prickly Lettuce	x	x		
Prenanthes alba L.	White Lettuce	x			x
P. altissima L.	Tall White Lettuce	x			
P. trifoliata (Cass.) Fern.	Tall Rattlesnake Root	x			x
SPHAGNACEAE					
Sphagnum fimbriatum Wils. ex Hook. f.					x
S. palustre L.			x		x
S. squarrosum Crome		x			
FISSIDENTALES					
Fissidens bushii (Card. & Ther.) Card. & Ther.					x
DICRANACEAE					
Onocophorus wahlenbergii Brid.			x		x
LEUCOBRYACEAE					
Leucobryum glaucum (Hedw.) Angstr. ex Fr.					x
BRYACEAE					
Pohlia nutans (Hedw.) Lindb.			x		
MNIACEAE					
Plagiomnium cuspidatum (Hedw.) Kop.					x
P. medium (B.S.G.) Kop.			x		x
AULACOMNIACEAE					

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SCIENTIFIC NAME	COMMON NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
Aulacomnium palustre (Hedw.) Schwaegr.		x			
ORTHOTRICHACEAE					
Ulota crispa (Hedw.) Brid.		x			
CLIMACIACEAE					
Climacium dendroides (Hedw.) Web. & Mohr.		x	x		x
LESKEACEAE					
Leskea polycarpa Hedw.		x			x
THUIDIACEAE					
Anomodon rostratus (Hedw.) Schimp.			x		x
AMBLYSTEGIACEAE					
Campylium chrysophyllum (Brid.) J. Lange var. brevifolium (Ren. & Card.) Grout			x		x
C. polygamum (B.S.G.) C. Jens.					x
Amblystegium varium (hedw.) Lindb.			x		x
BRACHYTHECIACEAE					
Brachythecium oxycladon (Brid.) Jaeg. & Sauerb.					x
B. salebrosum (Web. & Mohr.) B.S.G.			x		x
Rhynchostegium serrulatum (Hedw.) Jaeg. & Sauerb.					x

APPENDIX C : LIST OF PLANT SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

SCIENTIFIC NAME	COMMON NAME	SITE PHASE 4A	SITE PHASE 4B	SITE VICINITY PHASE 4A	SITE VICINITY PHASE 4B
HYPNACEAE					
Platygyrium repens (Brid.) B.S.G.			x		
Pylaisiella polyantha (Hedw.) Grout			x		x
Hypnum curvifolium Hedw.					x
Callicladium haldanianum (Grev.) Crum			x		x
Isopterygium elegans (Brid.) Lindb.			x		x
I. pulchellum (Hedw.) Jaeg. & Sauerb.			x		x
POLYTRICHACEAE					
Polytrichum juniperum Hedw.			x		x
LICHENS					
Cladina rangifera (L.) Nyl.					x
Cladonia bacillaris (Ach.) Nyl.			x		
Parmelia sulcata Tayl.			x		x

APPENDIX D

COMPARISON OF TREE IMPORTANCE VALUES IN THE SITE AND SITE VICINITY STUDY AREAS AND IN THE DECIDUOUS FOREST REGION OF ONTARIO

APPENDIX D

COMPARISON OF TREE IMPORTANCE VALUES IN THE SITE AND SITE VICINITY STUDY AREAS AND IN THE DECIDUOUS FOREST REGION OF ONTARIO

Data presented by Maycock (1963) and background file material (Maycock 1987) provide a basis against which to compare the results of quantitative vegetational analyses made in the preferred site and site vicinity study areas. Maycock (1963) studied 131 forest stands in the Deciduous Forest Region of Ontario, of which 15 were situated on the Haldimand Clay Plain, several in the Regional Municipality of Niagara.

Maycock (1963) employed the same Point-centred Quarter technique that was used for detailed Phase 4B botanical observations to quantify the presence of tree species in each of the 131 stands he studied. A summary of the importance values of tree species observed during Phase 4B field work is compared with these data (Table D-1).

The importance value is a numerical indication of the significance exerted on a stand by a particular species. The figure is calculated to include relative values for density, frequency and dominance. The sum of these values for each stand totals approximately 300. The higher a value, the more important a particular species is in a stand.

The averages attained as a result of Phase 4B field work were compared with those calculated by Maycock (1963) for

TABLE D-1 : A COMPARISON OF IMPORTANCE VALUES FOR TREE SPECIES BETWEEN GLL (1986) AND MAYCOCK (1963)

SPECIES	PREFERRED SITE AND VICINITY STAND NUMBER															AVERAGE IMPORTANCE VALUE (15 STANDS SITE AND VICINITY)*	AVERAGE IMPORTANCE VALUE (15 HALDIMAND CLAY PLAIN STANDS)+	AVERAGE IMPORTANCE VALUE (131 STANDS)	MAXIMUM IMPORTANCE VALUE (131 STANDS)
	OS-03	1	OS-12	OS-02	OS-09	6	OS-04	2	OS-06	OS-01	4	5	OS-13	OS-10	3				
Populus grandidentata		12						11								1.5	1.6	1.4	38.9
Prunus serotina		12	16	20		17		12	17	15	16			11		9.1	2.5	4.9	55.0
Ulmus americana		12	30					20			15	26	24	11	24	10.8	48.8	37.5	187.4
Quercus bicolor			17								32	95	24	31	22	14.7	1.4	3.6	74.5
Ostrya virginiana	11	14					28	11		18				11		6.2	5.8	4.8	45.1
Pinus strobus		12														0.8	1.5	4.8	99.5
Quercus alba		17	76		24	22	23	12	22	16	44	41	43	12		23.5	6.6	11.1	167.1
Q. rubra	40	54	43	28	105	41	27	66	52	19	20	22		14		35.4	19.3	18.6	151.0
Tilia americana	37	11	26	37		24	35	25	20	17	11				23	17.7	4.6	8.8	84.2
Acer rubrum	28	22	26	27	24	27	17	22	28	26	50	32	80	97	71	38.5	23.5	10.6	187.3
A. saccharum	77	95		69	78	38	57	61	87	78	11			21	18	46.0	26.5	39.3	226.6
Amelanchier arborea			16													1.1	0.7	0.1	6.4
Carya ovata	19		29			27	16	14	16		27	36	17		18	14.6	6.4	6.6	123.0
Crataegus											14					0.9	0.9	1.2	23.7
Fagus grandifolia	64	22		84	22	17	60	11	32	91						26.9	37.0	30.9	215.0
Fraxinus americana	25	23	21	37	29	88	37	17	26	19	29	49	88	27	41	37.1	32.4	18.2	120.6
Betula papyrifera					20									18		2.5	2.5	3.8	222.7
Populus tremuloides								11			26			35		4.8	0.6	4.3	295.5
Acer saccharinum													24		83	7.1	12.5	10.6	187.3
Q. macrocarpa														11		0.7	6.6	3.9	98.1
	Data Source : GLL (1986)																Data Source : Maycock (1963)		

NOTES :

- tree species listed in column 1 are those recorded in site and vicinity stands during Plase 4B and are arranged along soil moisture gradient from driest (top) to wettest (bottom)
- the 15 site and site vicinity stands are depicted by numbered code on Figures 5 and 6
- several species reported and assessed by Maycock (1963) were not observed in the preferred site or vicinity (e.g., Liriodendron tulipifera) and are not listed in this table

* - average importance values from 15 site and site vicinity stands (all situated on the Haldimand Clay Plain)

+ - average importance values from the 15 of Maycock's (1963) 131 stands situated on the Haldimand Clay Plain

- last two columns of table provide average importance values and maximum importance values for all 131 stands assessed by by Maycock (1963) in different environmental settings throughout the Deciduous Forest Region of Ontario all three stands and for the 15 situated on the Haldimand Clay Plain (Maycock 1987). The most important tree species recorded on and adjacent to the preferred site were very similar to the most important species recorded by Maycock in all 131 stands and in the 15 Haldimand Clay Plain stands. More variability was noted among the importance values derived for the minor species such as White Birch (Betula papyrifera) and White Pine.

The maximum value column on Table D-1 allowed a determination of whether the site and site vicinity stands contained abnormally high concentrations of those species with above average values. No species in the site and site vicinity study area were found at values higher than the maxima recorded by Maycock (1963).

APPENDIX E:

SUMMARY OF QUANTITATIVE STAND DATA

APPENDIX E

SUMMARY OF QUANTITATIVE STAND DATA

Table E-1 provides a summary of Point-centred Quarter data collected during Phase 4B investigations.

A list of plant species is presented which includes all species observed in woodlots studied quantitatively. The occurrence of species from woodlots examined in less detail and from non-wooded areas is documented in the list of flora (Appendix C). The arrangement of species on Table E-1 follows a sequence used to emphasize the soil moisture gradient. For example, species found only in dry-mesic areas are concentrated near the top of the table. Those found only in wet-mesic settings are concentrated near the bottom.

Table E-1 is presented in three different sections: trees, shrubs and herbs, and mosses and lichens. Grasses are included with the shrub and herb component.

For trees, constancy and importance values are presented. For shrubs and herbs, constancy and average percent cover are presented. Only constancy is provided for mosses and lichens. The terms constancy, importance values and average percent cover are discussed further in this section and are defined in Appendix M.

Table E-1 is intended to show the occurrence of all species across a soil moisture gradient and the importance of particular species in a stand's composition.

TABLE E-1 : SUMMARY OF QUANTITATIVE STAND DATA COLLECTED
IN PREFERRED SITE AND VICINITY DURING PHASE 4B

TREES	DRY - MESIC STAND NUMBER			CONSTANCY	IMPORTANCE VALUE	MESIC STAND NUMBER							CONSTANCY	IMPORTANCE VALUE	WET - MESIC STAND NUMBER					CONSTANCY	IMPORTANCE VALUE
	OS-03	1	OS-12			OS-02	OS-09	6	OS-04	2	OS-06	OS-01			4	5	OS-13	OS-10	3		
Juglans nigra	X			33									0							0	
Gleditsia triacanthos	X			33									0							0	
Populus grandidentata		12		33	4					11			14	1.6						0	
Prunus serotina		12	16	67	9.3	20	X	17		12	17	15	71	11.6	16	X	X	11		80	5.4
Ulmus americana		12	30	67	14			X		20	X	X	57	2.9	15	26	24	11	24	100	20
Quercus bicolor			17	33	5.7				X				14		32	95	24	31	22	100	40.8
Ostrya virginiana	11	14	X	100	6.3	X	X	X	28	11	X	18	100	8.1	X	X		11	X	80	2.2
Pinus strobus	X	12	X	100	4	X				X		X	43					X		20	
Quercus alba	X	17	76	100	31	X	24	22	23	12	22	18	100	17	44	41	43	12		80	28
Q. rubra	40	54	43	100	45.7	28	105	41	27	66	52	19	100	48.3	20	22		14		20	11.2
Tilia americana	37	11	26	100	24.7	37	X	24	35	25	20	17	100	22.6	11	X	X		23	80	6.8
Acer rubrum	28	22	26	100	25.3	27	24	27	17	22	28	26	86	24.4	50	32	80	97	71	100	66
A. saccharum	77	95		67	57.3	69	78	38	57	61	87	78	100	66.9	11			21	18	40	10
Amelanchier arborea	X	X	16	100	5.3	X	X			X		X	57					X		20	
Carpinus caroliniana	X	X	X	100		X	X	X	X	X	X		86		X	X		X	X	80	
Carya ovata	19	X	29	100	16	X		27	16	14	16	X	86	10.4	27	36	17		18	80	19.6
Crataegus sp.	X		X	67		X	X	X	X		X	X	86		14		X	X		60	2.8
Fagus grandifolia	64	22	X	100	28.7	84	22	17	60	11	32	91	86	45.3	X					40	
Fraxinus americana	25	23	21	100	23	37	29	88	37	17	26	19	100	36.1	29	49	88	27	41	100	46.8
Salix nigra				0				X					14							0	
Betula papyrifera				0			20						14	2.9				18		20	3.6
Pyrus communis			X	33									0		X					20	
Populus tremuloides				0						11			14	1.6	26			35		40	12.2
Acer saccharinum				0								X	14				24		83	40	21.4
Quercus palustris				0									0		X					20	
Q. macrocarpa				0									0					11		20	2.2

NOTES :

- 'X' represents a species' presence in a stand where no quantitative value was obtained; no quantitative data were obtained because the species occurred outside of Point - centred Quarter sampling areas, but were still observed in the stand during a walk through
- numerical figures on the table represent the importance value for trees and cover value for shrubs and herbs

TABLE E-1 : SUMMARY OF QUANTITATIVE STAND DATA COLLECTED IN LF-9C SITE AND VICINITY DURING PHASE 4B

SHRUBS AND HERBS	DRY - MESIC STAND NUMBER			CONSTANCY	AVERAGE PERCENT COVER	MESIC STAND NUMBER							CONSTANCY	AVERAGE PERCENT COVER	WET - MESIC STAND NUMBER					CONSTANCY	AVERAGE PERCENT COVER
	OS-03	1	OS-12			OS-02	OS-09	6	OS-04	2	OS-06	OS-01			4	5	OS-13	OS-10	3		
Chelidonium majus	X			33																	
Streptopus roseus		0.1		33	0.03																
Viola papilionacea	X			33																	
Hesperis matronalis	X			33																	
Arctium minus			X	33		X							14								
Tiarella cordifolia		X		33			X					X	29								
Galium lanceolatum			X	33				X					14								
G. circaezans			X	33							X		14								
Alliaria alliaria	6.1			33	2.03																
Carex pensylvanica			0.3	33	0.1	0.2			0.1	0.3		X	57	0.09							
Polystichum acrostichoides	X			33		X	X				X		43								
Smilacina stellata		X		33		X							14								
Trillium grandiflorum	X			33		X	X		X	X	X	X	86								
Oryzopsis asperifolia		X		33			X			X	X	X	57								
Claytonia virginica	X	X		67		X			X	X		X	57								
Prenanthes alba	X			33		X					X		29								
Epifagus virginiana	X			33		X			X			X	43								
Epipactis helleborine	0.1	X		67	0.03	X	X		X	X	X	X	86								
Erythronium americanum	X	X		67		X				X	X		43				X			20	
Euonymus obovatus	1.3	X	0.8	100	0.7	X	X	1.9	1.1	0.8	0.2	0.4	100	0.63	0.3	X		X		60	0.06
Geranium maculatum	X	X		67		X	X	X	X	0.5	0.1	X	100	0.09		X		X	X	60	
G. robertianum	0.2		0.3	67	0.17		X	0.1	X	0.4	X		71	0.07	X				X	40	
Glyceria striata	X			33		X	X		0.3				43	0.04	X	X	3.8	X	X	100	0.76
Hamamelis virginiana	X	X		67		X	0.8			1.3	X	X	71	0.3	X			1.1		40	0.22
Impatiens capensis	X	X	X	100		0.6	0.3	2.6	X	X	X	10.9	100	2.06	11.4	5	X		7.7	80	4.82
Lonicera dioica	X	X	X	100		X	X	0.3	X	0.1	X		86	0.06	X	3		0.1	X	80	0.62
Maianthemum canadense	X	0.1	0.3	100	0.13	X	0.5		X	X	0.3	X	86		1.1			1.4	X	60	0.5
Monotropa uniflora	X			33		X	X		X		X		57					X		20	

TABLE E-1 : SUMMARY OF QUANTITATIVE STAND DATA COLLECTED
IN LF-9C SITE AND VICINITY DURING PHASE 4B

SHRUBS AND HERBS	DRY - MESIC STAND NUMBER			CONSTANCY	AVERAGE PERCENT COVER	MESIC STAND NUMBER							CONSTANCY	AVERAGE PERCENT COVER	WET - MESIC STAND NUMBER					CONSTANCY	AVERAGE PERCENT COVER
	OS-03	1	OS-12			OS-02	OS-09	6	OS-04	2	OS-06	OS-01			4	5	OS-13	OS-10	3		
Onoclea sensibilis	X		X	67		X	X		X				43		1.1		X	1.5	X	80	0.52
Osmorhiza claytoni	X	X	X	100			0.1	X	X	X	X	X	86	0.01	X	X		1		60	0.2
Parthenocissus vitacea	X		X	67		0.2	X	0.1	X	0.2	0.7	X	100	0.17	0.7	10	X	0.5	5.4	100	3.32
Podophyllum peltatum	X			33		0.4	X		0.2	X	X		71	0.09				X		20	
Polygonatum pubescens	X	X	X	100		X	0.2		X	0.2	0.3	0.3	86	0.14	0.3	X		1.4	0.8	80	0.5
Anemone quinquefolia	X	0.1	0.8	100	0.3	X	0.1		X	0.2	0.1	X	86	0.06				X		20	
Arisaema atrorubens			X	33		X	X	0.1	X	X	X	0.2	100	0.04		2	X	X	0.1	80	0.42
Aster macrophyllus	0.1	X	X	100	0.03	X	X	0.1	0.7	1.1	4.6		86	0.93	4.3			2.5		40	1.36
Athyrium filix-femina	X	X		67		X	2.5			X	0.3		57	0.4	X			X	X	60	
Carex laxiflora	X		X	67		X	X	X		X	X		71		0.8		X	0.1	X	80	0.18
Uvularia sessilifolia	0.1			33	0.03	X	X		X	0.1		X	71	0.01		X		2.1		40	0.42
Viburnum acerifolium	X	0.1		67	0.03	X	X		X	0.1	2.5	X	86	0.14	0.4	X		0.3		60	0.14
Viola conspersa	X	X		67		X	X			X			43				X		X	40	
V. pubescens	X			33		X	X		X	X	X		71				X			20	
Viburnum recognitum	X			33							X		14		0.2		X	3.3	0.2	80	0.74
Sanicula marilandica	X			33						X	X		29		X					20	
Ambrosia artemisifolia		X		33				X					14		X					20	
Carex blanda		X		33						X	X		29		X	X			X	60	
Agrimonia gryposepala			0.5	33	0.17								0		0.9	X	X			60	0.18
Carex laxiculmis			X	33		X						X	29				X			20	
Fragaria virginiana			X	33				X	X			X	43		X	0.3				40	0.06
Viburnum lentago			X	33									0					X	X	40	
Cornus obliqua			X	33				X				X	29		3.5	31.3	X	2	0.2	100	7.4
Aster umbellatus			X	33		X	X		X	0.9			57	0.13	2.3	3		0.9	0.4	80	1.32
Circaea quadrisulcata	X			33		X			X		X	X	57				X		X	40	
Carex radiata			X	33			X		X				29						X	20	
Triosteum perfoliatum			X	33									0			X				20	
Rubus pubescens		X		33					X		X		29			4.8			3.8	40	1.72

TABLE E-1 : SUMMARY OF QUANTITATIVE STAND DATA COLLECTED IN LF-9C SITE AND VICINITY DURING PHASE 4B

SHRUBS AND HERBS	DRY - MESIC STAND NUMBER			CONSTANCY	AVERAGE PERCENT COVER	MESIC STAND NUMBER							CONSTANCY	AVERAGE PERCENT COVER	WET - MESIC STAND NUMBER					CONSTANCY	AVERAGE PERCENT COVER
	OS-03	1	OS-12			OS-02	OS-09	6	OS-04	2	OS-06	OS-01			4	5	OS-13	OS-10	3		
Osmorhiza longistylis	X	X		67			X	2.1		X	X		57	0.3		X				20	
Fragaria vesca	X		X	67		X	X		X	X			57		0.6			0.2	0.2	60	0.2
Dryopteris spinulosa	X			33		X		X	X		X		57				X	X		40	
Solanum dulcamara		X	0.5	67	0.17												1.3	X	X	60	0.26
Potentilla simplex	X		X	67			X		0.2	X	X		57	0.03	0.5			0.1		40	0.12
Taraxacum officinalis		X		33			X			X		0.1	43	0.01					X	20	
Carex tenera	X			33		X	X					X	43					X	X	40	
Pteridium aquilinum	X			33									0		X					20	
Rhus radicans	X	0.7	X	100	0.23	X	X	X	X	X		X	86		0.6	3	X		0.4	80	0.8
Ribes cynosbati	X	X	X	100		X	4.7	0.4	0.3	0.1	X		86	0.79	0.3		X		0.4	60	0.14
Rosa blanda	X			33					X			X	29						X	20	
Rubus idaeus var. strigosus	X		X	67		X	0.2	5.7	X	X		X	86	0.84	0.8		X	X		60	0.16
Sambucus canadensis	X			33			X	X	X	X		X	71					X	X	40	
Sanicula gregaria	X	X	6.3	100	2.1			0.3	X	X	3.2		57	0.5	0.4		X	0.2		60	0.12
Smilacina racemosa	X	X	X	100		X	0.4	X	X	X	X	X	100	0.06				0.2	X	40	0.04
Prunus virginiana	X	X	X	100		1	X	0.9		X	0.3	X	86	0.31	X	17.5		X	X	80	3.5
Carex interior	X			33					X				14		X					20	
C. gracillima	X	X		67		X	X		0.1	0.1			57	0.03	X	X		X	X	80	
Viola cucullata	X			33		X							14				X			20	
Solidago rugosa	X			33									0					0.1		20	0.02
Brachyelytrum erectum		X		33	0.27		X		X	X	X		57					X		20	
Carex rosea		X	X	67			X		X		X	X	57		X	X				40	
Galium aparine		X		33		X				0.1		X	43	0.01	0.5					20	0.1
G.triflorum			X	33			X		X		X		43					X		20	
Geum canadense			0.8	33					X		X	X	43				X	X		40	
Rubus allegheniensis			X	33			0.5		X			X	43	0.07	X		X	1	X	80	0.2
Spirea alba			X	33									0		X	X	X	X	X	100	
Vaccinium corymbosum			X	33									0		X			X	X	60	

TABLE E-1 : SUMMARY OF QUANTITATIVE STAND DATA COLLECTED IN LF-9C SITE AND VICINITY DURING PHASE 4B

SHRUBS AND HERBS	DRY - MESIC STAND NUMBER			CONSTANCY	AVERAGE PERCENT COVER	MESIC STAND NUMBER							CONSTANCY	AVERAGE PERCENT COVER	WET - MESIC STAND NUMBER					CONSTANCY	AVERAGE PERCENT COVER
	OS-03	1	OS-12			OS-02	OS-09	6	OS-04	2	OS-06	OS-01			4	5	OS-13	OS-10	3		
Viburnum rafinesquianum			7.8	33	2.6																
Viola incognita							X		0.7				29	0.1	X					20	
Conopholis americana							X						14								
Corallorhiza maculata							X						14								
Pinus strobus							X						14								
Cardamine douglassii							X						14								
Viburnum cassinoides						X				X			29								
Aster cordifolius							X						14					0.3		20	0.06
Actaea rubra								X					14								
Medeola virginiana											X		14								
Prunus nigra							X						14								
Solidago nemoralis									X				14								
Prenanthes trifoliata									X				14								
Smilax herbacea							0.1						14	0.01							
Festuca obtusa							X			X			29								
Galium boreale											X		14								
Carex platyphylla											X		14								
Luzula acuminata											X		14								
Carex convoluta												X	14								
Hypericum virginicum												X	14								
Carex stipata								X					14								
Galium asprellum								X					14								
Botrychium virginianum								X					14								
Carex pedunculata						X				X	X		43								
Dryopteris marginalis						X				X			29								
Veronica officinalis						X							14								
Berberis thunbergii									4.7		2.5		29	1.03							
Coptis groenlandicum									X				14								
									X				14								

TABLE E-1 : SUMMARY OF QUANTITATIVE STAND DATA COLLECTED IN LF-9C SITE AND VICINITY DURING PHASE 4B

SHRUBS AND HERBS	DRY - MESIC STAND NUMBER			CONSTANCY	AVERAGE PERCENT COVER	MESIC STAND NUMBER							CONSTANCY	AVERAGE PERCENT COVER	WET - MESIC STAND NUMBER					CONSTANCY	AVERAGE PERCENT COVER
	OS-03	1	OS-12			OS-02	OS-09	6	OS-04	2	OS-06	OS-01			4	5	OS-13	OS-10	3		
Carex brunnescens										X			14								
Viola sororia										X			14								
Vaccinium pallidum										X			14								
Carex tetanica var. woodii										X			14								
Viola affinis						X							14								
Phlox divaricata						X							14								
Hepatica americana									X	X	X		43								
Ilex verticillata										X			14		X			2		40	0.4
Vaccinium angustifolium							X				X		29						X	20	
Lycopus americanus							X						14					X	X	40	
Cornus florida											X		14					X		20	
Gaultheria procumbens							X						14					0.1		20	0.02
Solidago bicolor									X				14		X					20	
Apocynum androsaemifolium										X			14		X					20	
Rubus hispidus									X				14		0.7				X	40	0.14
Viola septentrionalis									0.1				14	0.01				0.2		20	0.04
Trientalis borealis											X		14					0.2	X	40	0.04
Rhamnus alnifolia											X		14						X	20	
Rosa palustris											X		14		X			X	X	60	
Smilax tamnoides var hispida							X				X		29		X	0.5		X	X	80	0.01
Dathonia spicata							X	X				X	43		X					20	
Carex tribuloides								X					14		X					20	
Amphicarpa bracteata							X						14						7.4	20	1.48
Aralia nudicaulis							2.2		X		X	X	57	0.31				1.5	X	40	0.3
Cicuta maculata							X						14				X	0.1	2.1	60	0.44
Osmunda cinnamomea							X		X				29					X		20	
Ranunculus abortius						X				0.1	X	X	57	0.01			X		X	40	
Geum virginianum						X		X					29			X			0.5	40	0.1

TABLE E-1 : SUMMARY OF QUANTITATIVE STAND DATA COLLECTED IN LF-9C SITE AND VICINITY DURING PHASE 4B

SHRUBS AND HERBS	DRY - MESIC STAND NUMBER			CONSTANCY	AVERAGE PERCENT COVER	MESIC STAND NUMBER							CONSTANCY	AVERAGE PERCENT COVER	WET - MESIC STAND NUMBER					CONSTANCY	AVERAGE PERCENT COVER
	OS-03	1	OS-12			OS-02	OS-09	6	OS-04	2	OS-06	OS-01			4	5	OS-13	OS-10	3		
Carex projecta								X					14		X				X	40	
Comandra umbellata									X				14		0.3					20	0.33
Carex intumescens								X		X			29			X		0.1	X	60	0.02
Hystrix patula								X	X				29			0.3	X		X	60	0.33
Oxalis europea								0.1	X				29	0.01	0.1	X			0.1	60	0.04
Prunella vulgaris								X	X			X	43					X		20	
Geum allepicum															X					20	
Viola selkerkii															0.1				0.3	40	0.08
Thelypteris palustris															X				X	40	
Phalaris arundinacea															X					20	
Daucus carota															X					20	
Carex bromoides															X				X	40	
Lilium michiganense																1	X		3.8	60	0.96
Solidago hispida																X			X	40	
S. gigantea																X				20	
Cephalanthus occidentalis																	9			20	1.8
Glyceria grandis																	0.1			20	0.02
Lysimachia thyrsiflora																	X		X	40	
Urtica dioica ssp. gracilis																	X			20	
Boehmeria cylindrica																	0.6		X	40	0.12
Iris versicolor																	X	X	X	60	
Carex lupulina																	X			20	
Rubus flagellaris																		0.7		20	0.14
Osmunda regalis																		X		20	
Aronia melanocarpa																		X		20	
Botrychium multifidum																		X		20	
Lycopodium complanatum																		X		20	
Echinocystis lobata																		X		20	

TABLE E-1 : SUMMARY OF QUANTITATIVE STAND DATA COLLECTED IN LF-9C SITE AND VICINITY DURING PHASE 4B

SHRUBS AND HERBS	DRY - MESIC STAND NUMBER			CONSTANCY	AVERAGE PERCENT COVER	MESIC STAND NUMBER							CONSTANCY	AVERAGE PERCENT COVER	WET - MESIC STAND NUMBER					CONSTANCY	AVERAGE PERCENT COVER
	OS-03	1	OS-12			OS-02	OS-09	6	OS-04	2	OS-06	OS-01			4	5	OS-13	OS-10	3		
Stellaria longifolia																		X		20	
Lysimachia ciliata																			X	20	
Carex lurida																			X	20	
Solidago patula																			X	20	
S. nemoralis																			X	20	
Carex lupulina																			X	20	
C. crinita																			X	20	
C. lurida																			X	20	
Quercus rubra																			X	20	
Ulmus americana	X			33							X	X	29								
Cinna arundinacea															X		0.1		X	60	0.02
Lycopus uniflorus																		X	0.7	40	0.14
Vaccinium myrtilloides															0.3					20	0.06
Waldsteinia fragaroides															X					20	
Pilea pumila																	0.4			20	0.08

TABLE E-1 : SUMMARY OF QUANTITATIVE STAND DATA COLLECTED
IN LF-9C SITE AND VICINITY DURING PHASE 4B

MOSSES AND LICHENS	DRY - MESIC STAND NUMBER			CONSTANCY	AVERAGE PERCENT COVER	MESIC STAND NUMBER							CONSTANCY	AVERAGE PERCENT COVER	WET - MESIC STAND NUMBER					CONSTANCY	AVERAGE PERCENT COVER
	OS-03	1	OS-12			OS-02	OS-09	6	OS-04	2	OS-06	OS-01			4	5	OS-13	OS-10	3		
Plagiomnium medium	X	X		67																	
Fissidens bushii	X			33																	
Ulota crispa		X		33																	
Rhynchostegium serrulatum	X			33		X							14								
Brachythecium oxycladon	X			33					X				14					X		20	
Campylium chrysophyllum	X			33									0						X	20	
Isopterygium pulchellum		X		33		X	X	X		X	X		71					X	X	40	
Parmelia sulcata		X		33		X	X	X				X	57		X					20	
Polytrichum juniperinum		X		33		X	X		X	X	X		71		X					20	
Pylaisiella polyantha	X			33		X			X	X	X	X	71		X					20	
Callicladium haldanianum	X			33		X				X			29		X			X		40	
Anomodon rostratus									X	X			29								
Brachythecium salebrosu										X	X	X	43								
Leskea polycarpa						X							14								
Campylium polygamum							X						14								
Hypnium curvifolium							X						14								
Leucobryum glaucum							X		X				29								
Isopterygium elegans							X	X					29		X	X		X		60	
Parmelia subrudecta									X				14		X					20	
Climacium dendroides										X			14		X	X		X		60	
Onocophorous wahlenbergii						X	X	X	X		X		71			X				20	
Cladonia bacillaris															X					20	
Sphagnum palustre															X	X		X		60	
Platygyrium repens															X					20	
Plagiomnium cuspidatum																		X		20	
Sphagnum fimbriatum																		X		20	

The moisture gradient has been emphasized by grouping the data for similar stands together, so that patterns of tree representation characteristic of certain soil moisture conditions emerge. Dry-mesic stands are grouped at the left hand side of the table, mesic stands are grouped centrally and wet-mesic stands are grouped to the right hand side of the table.

Constancy is a percent measure of the occurrence of a particular species. For example, a tree occurring in one of three dry-mesic stands, or in one third of the stands, receives a value of 33. It has been calculated for each species and each soil moisture segment to show whether a species occurred more frequently under one soil moisture condition than under another.

For trees, importance values are presented. Importance values represent the degree to which a species exerts influence on a stand. The higher the value, the more important it is in a particular stand. Arranged according to a soil moisture gradient, Table E-1 allows an assessment of under what conditions a tree species was most important.

For example, Red Maple occurred in dry-mesic stands with an importance value of 25.3; in mesic stands at 24.4, and in wet-mesic stands at 66. Obviously this soft maple species was more important at the wet end of the scale.

For shrubs, herbs and grasses, average percent cover values were calculated in place of importance values, since methods for the calculation of importance values apply only to trees. Average percent cover values were calculated from quantitative observations of plant cover made for quadrants placed about every second Point-centred Quarter observation point. Within each stand, average percent cover values were calculated for each species quantified (Table E-1).

A higher average percent cover value implies a greater presence or importance of a species. Again, the data are presented according to soil moisture to indicate under what physical conditions a species was more important.

For example, Spotted Jewelweed had average percent cover values of 0.0, 2.06 and 4.82% for dry-mesic, mesic and wet mesic stands, respectively. This suggests a greater occurrence of the species at the wet end of the moisture scale.

Only constancy values are presented for the moss and lichen species listed in Table E-1. These species were not quantitatively studied in Phase 4B.

APPENDIX F

RARITY AND SIGNIFICANCE OF PLANT SPECIES

APPENDIX F

RARITY AND SIGNIFICANCE OF PLANT SPECIES

TABLE OF CONTENTS

PAGE

F-1 RARITY F-3

F-1.1 SITE AND SITE VICINITY RARITY DETERMINATION F-4

F-2 SIGNIFICANCE F-9

F-2.1 DETERMINATION OF SIGNIFICANCE F-9
F-2.2 ASSIGNMENT OF SIGNIFICANCE FOR EACH RARE SPECIES F-15
F-2.2.1 HIGH SIGNIFICANCE SPECIES F-15
F-2.2.2 MEDIUM SIGNIFICANCE SPECIES F-17
F-2.2.3 LOW SIGNIFICANCE SPECIES F-22

FIGURES

FIGURE F-2-1 - EXAMPLES OF NORTH AMERICAN RANGES OF RARE PLANT SPECIES F-12

FIGURE F-2-2 - EXAMPLES OF SOUTHERN ONTARIO RANGES OF RARE PLANT SPECIES F-13

TABLES

TABLE F-1 - SUMMARY OF PLANT SPECIES RARITY DEFINITIONS AND CRITERIA USED BY PUBLISHED SOURCES F-6

APPENDIX F

RARITY AND SIGNIFICANCE OF PLANT SPECIES

F-1 RARITY

The concept of rarity generally refers to a species with a limited population size or distribution within a defined geographic area. The definition of rarity varies depending upon the geographic area involved and the criteria included in the assessment. Terms used to describe rarity can also differ (e.g., endangered, threatened, rare, uncommon, etc.).

Rarity can result from both natural and man-made influences. Before man's impact on this continent certain plant species may have been rare as a result of very specialized environmental requirements which were limited in nature. These species may still be represented in scattered pockets where such conditions are met.

With man's intervention came the reduction of natural habitat over a widespread area. Even widely distributed rare species could have become more limited as a result. Exploitation of certain species because of their commercial value (e.g., Ginseng, *Panax quinquefolium*) contributed to some species becoming rare, as did insect and disease problems. The native Chestnut (*Castanea dentata*) for example, has been almost completely eliminated because of a disease known as Chestnut Blight (Hosie 1979).

Rarity is well recognized for its role in promoting conservation. Much has been written about the importance or potential importance of these rare species and the habitats which support them. There is a philosophical argument that man should be obliged to prevent the extirpation or removal of any species.

Wild plant materials have long been recognized for their contribution towards advances in both the medical and agricultural fields. The removal of one rare species could represent the loss of some as yet unknown value to those communities.

The presence of a particular rare species, especially near the limit of its known range, could represent potentially important genetic material. A given geographic population at its northern extreme, for example, may possess certain adaptive traits which could allow it to survive under harsher climatic conditions.

The Ontario Rare Woody Plants Program administered by the University of Guelph is an example of a program dedicated to the maintenance of genetic material of particular rare tree and shrub species.

Other potential benefits of rare species include scientific research and education values.

F-1.1 SITE AND SITE VICINITY RARITY DETERMINATION

Rarity of plant species was assessed for the preferred site and site vicinity after the compilation of a list of vascular plants, mosses and lichens which occur in these study areas.

Published reports listing plant status relevant to the study area were reviewed. For vascular plants, two information sources are directly relevant in that their study areas included the preferred site and site vicinity study areas. These are reports issued by the National Museum of Natural Sciences (Argus and White 1977, 1982, 1983; Argus and Keddy 1984; Argus, in press) and by Zander and Pierce (1979). National Museum of Natural Sciences reports assign status at a provincial (Ontario) and national level, while Zander and Pierce (1979) refer to plant status on a regional basis. This regional area, known as the Niagara Frontier Region, encompasses lands within a 50 mile (80 km) radius of Buffalo, New York (including that portion of Ontario which contains the preferred site and site vicinity).

Four other sources (Zenkert 1934; Landon 1960; Mitchell _et al_. 1980; Sutherland 1987) provide additional background information on plant status. These are listed with the former two on Table F-1. Table F-1 illustrates the different approaches taken to determine rarity and the geographical context of each source.

Zenkert (1934) conducted work in the same Niagara Frontier Region referred to by Zander and Pierce (1979). Much of Zenkert's previous work was included in Zander and Pierce (1979). Zenkert provides more detailed indications of rarity for some species, as well as an historical perspective.

Landon (1960) and Cruise (1969) provide some indication of the historical status of plants in Norfolk County (now incorporated within the Regional Municipality of Haldimand-Norfolk), Ontario, situated to the west of the study area. Sutherland (1987) provides a recent assessment of rare plant species status in the

TABLE F-1 : SUMMARY OF PLANT SPECIES RARITY DEFINITIONS AND CRITERIA USED BY PUBLISHED SOURCES

SOURCE	CRITERIA USED FOR DETERMINING RARITY	STUDY AREA USED FOR DETERMINING RARITY	TERMS USED BY EACH SOURCE	DOCUMENTED APPLICATION OF CRITERIA	COMMENTS
National Museum of Natural Sciences (Argus and White 1977,1982,1983; Argus and Keddy 1984; Argus, in press)	- geographic - demographic - vulnerability to environmental change	Ontario and Canada	rare, threatened, endangered, extirpated, extinct	- applications of criteria are species dependent - well documented criteria and definitions	- current information - published and unpublished material was reviewed
Zander and Pierce (1979)	- apparently geographic and demographic	a 50 mile (80km) radius: centred in Buffalo, N.Y.	protected, rare, endangered, absent	- application not documented - terms defined	very little data from Ontario portion of study area
Zenkert (1934)	- geographic - demographic	a 50 mile (80km) radius: centred in Buffalo, N.Y.	frequency : very rare, rare, infrequent, rather frequent, frequent, rather common, common, very common abundance : solitary, sparse, rather abundant, abundant, very abundant, gregarious, dominant	- application not documented - terms not defined	- very out-dated - very little information regarding distribution in Ontario (more specific to New York State) - used as background by Zander and Pierce (1979)
Landon (1960)	- apparently geographic and demographic	Norfolk County, Ontario (now part of the Regional Municipality of Haldimand-Norfolk)	abundant, plentiful, frequent infrequent, occasional, scarce, rare	- application not documented - terms not defined	Norfolk County includes a portion of the Haldimand Clay Plain, which is the dominant physiographic feature in site and site vicinity study areas
Cruise (1969)	- geographic	Norfolk County, Ontario (now part of the Regional Municipality of Haldimand-Norfolk)	frequency terms : scarce, infrequent, frequent, common, abundant	- application documented - terms defined	Norfolk County includes a portion of the Haldimand Clay Plain, which is the dominant feature in the study area

TABLE F-1 : SUMMARY OF PLANT SPECIES RARITY DEFINITIONS AND CRITERIA USED BY PUBLISHED SOURCES

SOURCE	CRITERIA USED FOR DETERMINING RARITY	STUDY AREA USED FOR DETERMINING RARITY	TERMS USED BY EACH SOURCE	DOCUMENTED APPLICATION OF CRITERIA	COMMENTS
Mitchell et al. (1980)	- geographic - demographic - vulnerability to exploitation	New York State	twelve coded terms such as threatened, limit of range	- application not documented - terms not defined	- very current, updated in 1986 - 1980 list was supplementec (Mitchell,pers. comm.,1986) - no Ontario data - some areas of similar physiographic characteristics to site and site vicinity study areas
Mitchell and Sheviak (1981)	- geographic - demographic - vulnerability to exploitation	New York State	- four main status levels: extirpated, endangered, threatened and commercially exploited - appendices of rare and protected plants	- application relatively well documented - terms defined	- no Ontario data
Clemants (1986)	- geographic - demographic - vulnerability to biological factors	New York State	- numerous status codes : ranked based on global, federal, state geographic areas - also provides ranking by New York State Museum and a Protected Status	- well documented application of criteria - terms well defined	- no Ontario data - current
Sutherland (1987)	- geographic - demographic	Regional Municipality of Haldimand-Norfolk	- status : common, uncommon, very uncommon, rare - distribution : adventive, wide spread, scattered, local	- status determined on basis of frequency of known stations for each species	- very current information - very comprehensive study - study area includes fairly large portion of Haldimanc Clay Plain

Regional Municipality of Haldimand-Norfolk. Mitchell et al. (1980), Mitchell and Sheviak (1981) and Clemants (1986) give the status of plants occurring in New York State, situated to the east of the study area.

Although they pertain to geopolitical areas outside the Regional Municipality of Niagara, the latter five publications were reviewed because the physical conditions (e.g., the presence of a clay plain) that prevail in the site and site vicinity study areas also occur, to some extent, in the Regional Municipality of Haldimand-Norfolk and New York State.

For mosses, a checklist of Ontario mosses (Ireland and Cain 1975) was referred to. In the absence of a checklist of Ontario lichens, a checklist of lichens for the Ottawa area (Brodo 1981) provides the most current status.

F-2 SIGNIFICANCE

F-2.1 DETERMINATION OF SIGNIFICANCE

Because definitions of rarity varied and the geographical units within which rarity was designated differed among the sources reviewed, there was a need to apply a more standard means of comparison to judge the importance of the rare species in the preferred site and site vicinity study areas.

Three levels of significance (high, medium and low) were defined and applied to the eight rare plant species encountered during the Phase 4B study. The criteria used in significance determination included published status, geographic and demographic factors, and other considerations, including professional judgement and a knowledge of local flora.

Published status was based upon fairly thorough, recent investigations of rare species within a particular geopolitical area (e.g., county, region, province, state) It was accepted as a starting point in significance determination. All eight of the rare plant species discussed here were reported as rare in the Niagara Frontier Region (Zander and Pierce 1979) or in Ontario and Canada (Argus and White 1977, 1982, 1983; Argus and Keddy 1984; Argus in press).

The other factors used were also applied to the eight plant species designated as rare. These factors were applied in order to refine the degree of significance. The geographic factors (i.e., distribution, habitat) were given more importance than demographic factors. In most cases, the geographic factors were assessed on the basis of comparable levels of information. Demographic factors (i.e. population size, condition) were based on unequal levels of information among species, making a complete comparison difficult.

Published status was obtained from the two major data sources described in Appendix F-1. It was considered to be the first and most important step in the assignment of significance. Only plant species defined as rare by either the National Museum of Natural Sciences or Zander and Pierce (1979) were considered significant. The remaining criteria were applied to further define the published status. This involved a more precise determination of current species distribution and abundance from both a regional and provincial perspective. This was necessary since some information was dated (Zander and Pierce 1979) and in some cases additional sources of data are available which were not incorporated into the published accounts.

Geographic factors are used by many authors to define rarity. Argus and White (1977, 1982, 1983) and Mitchell et al. (1980) use an analysis of the geographic range of a species as the first criterion in rarity assessment. As discussed in Appendix F-1, there are a variety of factors which influence the extent of a species' geographic range. Collectively, the geographic factors were considered the second most important criterion and were generally all assessed equally.

In this assessment, the species' North American range, its distribution within the Regional Municipality of Niagara in relation to that range, and the number of known occurrences in the Region were considered. Data other than that provided in the

National Museum of Natural Sciences works and Zander and Pierce (1979) were also reviewed. The works of Gleason (1952), Fernald (1950) and Scoggan (1978-79) were consulted to provide a definition of a species' North American range. Fowells (1965) and Soper and Heimburger (1982) provided further information on the ranges of trees and shrubs, respectively. The smaller the species range, the greater the level of importance attached to this factor. The potential for the extirpation of a species or an important population of that species was expected to be higher for a species with a more restricted geographic range. This assumption was made without consideration of abundance within these ranges.

Examples of North American and southern Ontario ranges of selected rare plant species are depicted on Figures F-2-1 and F-2-2. Both figures are provided to depict the relative sizes of the known ranges of plant species which were examined during an assignment of significance. The results of these examinations are discussed in Appendix F-2.2.1.

The locations of rare plant species in the preferred site and site vicinity study areas (Figures 8 and 9) were examined in relation to the North American ranges of these species to determine where a range extension may occur. Several of the rare species encountered are characteristic of Carolinian Zone flora and as such, reach the northern limits of their range near the preferred site and site vicinity study areas.

A report identifying Environmentally Sensitive Areas in the Regional Municipality of Niagara (Brady et al. 1980) and computerized files of herbaria records maintained by the National Museum of Natural Sciences (1986a, 1986b, 1986c) provided

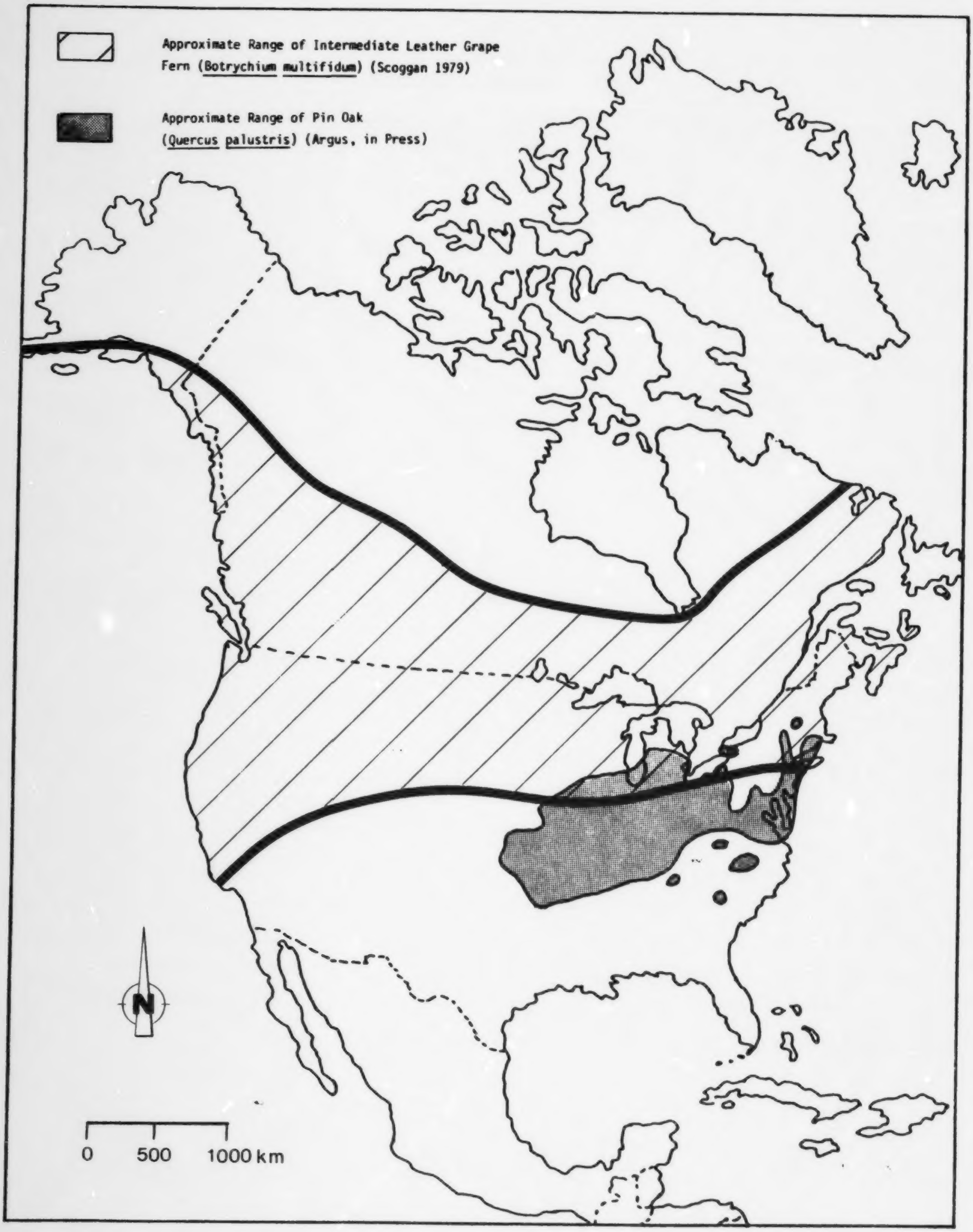
▨ Approximate Range of Intermediate Leather Grape Fern (Botrychium multifidum) (Scoggan 1979)
▩ Approximate Range of Pin Oak (Quercus palustris) (Argus, in Press)
N
0
500
1000 km

Figure F-2-1

EXAMPLES OF NORTH AMERICAN RANGES OF RARE PLANT SPECIES

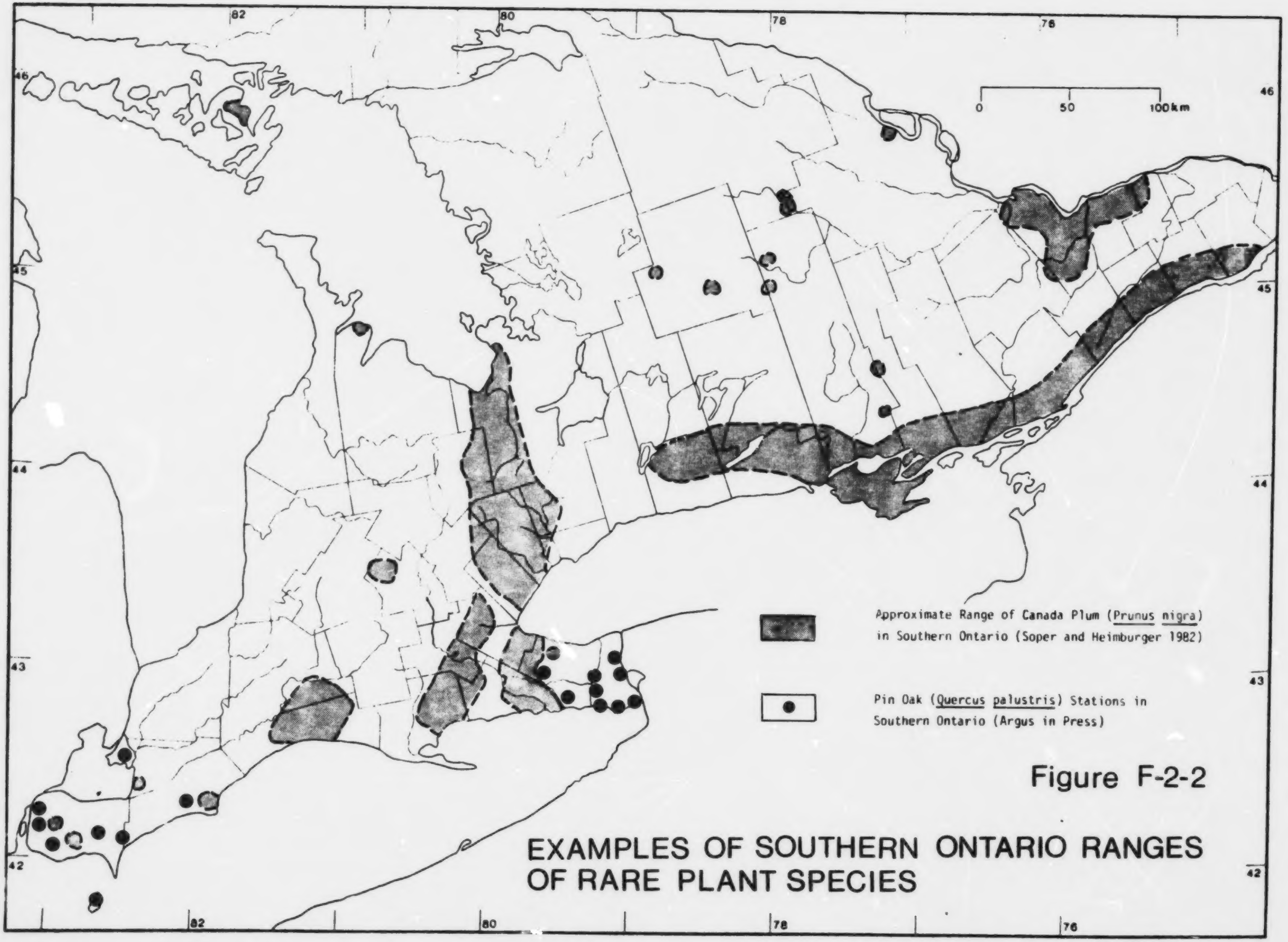
82
80
78
76
46
45
44
43
42
0
50
100km
Approximate Range of Canada Plum (Prunus nigra) in Southern Ontario (Soper and Heimburger 1982)
Pin Oak (Quercus palustris) Stations in Southern Ontario (Argus in Press)

Figure F-2-2

EXAMPLES OF SOUTHERN ONTARIO RANGES OF RARE PLANT SPECIES information concerning numbers and locations of specific rare plant species in the Regional Municipality of Niagara.

In some instances, it was not possible to ascertain whether overlap occurred in the number of stations reported for each species by different authors. This factor was examined cautiously, as the number of stations could also reflect the level of field effort applied in different areas. Furthermore, a greater number of stations could be expected to occur for the more obvious species (e.g., trees as opposed to sedges). A smaller number of reported stations suggested that some species, especially those with specific habitat requirements (e.g., Small Bedstraw) could have a more limited regional population.

The demographic factor entered into an assessment of significance: the population size and population characteristics of the rare species which occurred in the preferred site and site vicinity study areas. The number of individual plants, the apparent health of the plants and evidence of regeneration were noted. Signs of dieback on plants (e.g., yellow wilted leaves, peeling bark and dead branches) were recorded. Seed production and the presence of younger individual specimens were interpreted as signs of regeneration. These data were evaluated carefully, since the lack of observations of regeneration could indicate that field visits did not coincide with the presence of seeds, fruits, etc. of a particular species.

Where different populations of the same rare plant species occurred in the site and site vicinity study areas, a greater level of importance was attached to the larger population displaying healthy regeneration.

The significance of regeneration for a single population was more difficult to determine, as little was known about these characteristics in populations elsewhere in the species' range. However, it was assumed that the presence of regeneration contributed to a more significant occurrence. Regeneration could represent an important source of propagules and genetic material and suggests the presence of a self-sustaining population with the likelihood of long-term stability.

Other considerations which entered into the assignment of significance included professional judgement and a local knowledge of species distribution and abundance gained from field observations made in several locales within the Regional Municipality of Niagara during OWMC Phase 3B, 4A and 4B field work.

F-2.2 ASSIGNMENT OF SIGNIFICANCE FOR EACH RARE SPECIES

An evaluation of the significance of each rare species, based upon the factors discussed above, is presented in the following text. The eight rare plant species are presented in order of assigned significance, from high to low.

F-2.2.1 HIGH SIGNIFICANCE SPECIES

- Pin Oak, *Quercus palustris*

Published status: Rare in Canada and Ontario (Argus, in press)
Common in the Niagara Frontier Region
(Zander and Pierce 1979)

Geographic factors:

(1) The relatively small range of this species includes mid- to northern and northeastern United States, extreme

southwestern Ontario and the Niagara Peninsula. The Niagara Peninsula population of Pin Oak is a northern disjunct of the species' continental distribution (Fowells 1965; Figure F-2-1).

(2) The presence of Pin Oak on the preferred site appears to represent one of the westernmost stations of the species on the Niagara Peninsula. Pin Oak is not known to occur to the west in Regional Municipality of Haldimand-Norfolk (Gartshore *et al*. 1987b)

(3) Approximately 57 stations of Pin Oak are known for the Regional Municipality of Niagara.

Demographic factors:

(1) The population of Pin Oak on the preferred site is represented by six individual trees, including two saplings. This suggests recent regeneration. The four larger trees were fruiting.

Evaluation Comments:

Although this species has a relatively small North American range, it is apparently widespread in the Regional Municipality of Niagara. This represents an apparently healthy and regenerating population and a westward extension of the species' distribution on the Niagara Peninsula, as mapped by Argus (in press). There are two more westerly stations for Pin Oak, both approximately 15 km west-northwest of the preferred site, which were recently discovered by OMNR (1987b). Pin Oak is considered regionally common by Zander and Pierce (1979).

F-2.2.2 MEDIUM SIGNIFICANCE SPECIES

- Wood's Sedge, *Carex woodii*

Published status: Rare in the Niagara Frontier Region (Zander and Pierce 1979).

Geographic factors:

(1) The North American range of this sedge includes a small portion of the northeastern United States, as well as portions of southern Ontario (primarily in the Deciduous Forest Region and in the southernmost portions of the Great Lakes-St. Lawrence Forest Region).

(2) The station on the preferred site appears to be centrally located within the species' North American range.

(3) This occurrence represents only the second known station in the Regional Municipality of Niagara. There are only two known stations of Wood's Sedge in the Regional Municipality of Haldimand-Norfolk (Gartshore *et al*. 1987b).

Demographic factors:

(1) The occurrence of this species on the preferred site is restricted to several stems, some of which were fruiting at the time of observation.

Evaluation comments:

Although centrally located within the small North American range and not provincially rare, the presence of only one other known station of Wood's Sedge in the Regional Municipality of Niagara represents a significant occurrence. This sedge, which was once considered provincially rare (Argus and White

1977), has recently been delisted because it is considered widespread or common (Argus and White 1982). It is considered common in the neighbouring Regional Municipality of Haldimand-Norfolk (Sutherland 1987) but is known from only one other station in the Regional Municipality of Niagara. It is therefore considered to be an occurrence of medium significance. The regional status likely reflects the fact that this is an easily overlooked species and thus not often collected.

- Black Gum, *Nyssa sylvatica*

Published status: Rare in Canada and Ontario (Argus, in press)
Common in the Niagara Frontier Region
(Zander and Pierce 1979)

Geographic factors:

(1) The North American range of this species covers half of eastern United States, north into southern Ontario.

(2) The station on the preferred site is near the northern limit of the species' range.

(3) The occurrence of Black Gum in the study area represents one of approximately 29 known stations in the Regional Municipality of Niagara.

Demographic factors:

(1) The presence of 31 saplings and 75 seedlings immediately adjacent to the preferred site represents a healthy, regenerating population.

Evaluation comments:
Significant as a regenerating population. It was not determined whether the presence of seedlings is a response to suckering from roots or from seed germination. This station is near the northern limit of the species' relatively large North American range. Similar stands of regenerating Black Gum were encountered to the west in the Regional Municipality of Haldimand-Norfolk (Sutherland 1987), although few mature stems were encountered.

- Southern Arrow-wood, *Viburnum recognitum*

Published status: Rare in Canada and Ontario (Argus and Keddy 1984);
Common in the Niagara Frontier Region (Zander and Pierce 1979).

Geographic factors:

(1) The North American range of this species is similar to that of Black Gum. It is found in the eastern half of the United States, extending north into southern Ontario.

(2) The stations in the site and site vicinity study areas are near the northern limit of the species' North American range.

(3) Approximately 11 stations of Southern Arrow-wood are presently known to occur in the Regional Municipality of Niagara.

Demographic factors:

(1) Dense stands of this shrub were observed in several localities throughout the site and site vicinity study areas. No evidence of regeneration was observed.

Evaluation comments:
This species has a large North American range and the stations are near its northern limit. Southern Arrow-wood appeared to be abundant in several other Niagara Region localities examined during Phase 4A and is considered to be common in the Regional Municipality of Haldimand-Norfolk (Sutherland 1987).

- Small Bedstraw, Galium trifidum

Published status: Rare in the Niagara Frontier Region (Zander and Pierce 1979).

Geographic factors:

(1) This species has a large North American range, occurring across the central two-thirds of the continent.

(2) The station on the preferred site is near the southern limit of the species' North American range.

(3) There are only two previously known stations of Small Bedstraw in the Regional Municipality of Niagara.

Demographic factors:

(1) Several stems were found, with an abundant amount of seed material on each.

Evaluation comments:
The station on the preferred site occurs near the southern limit of this species' large North American range. Small Bedstraw is likely easily overlooked and few data regarding distribution and abundance are available.

- Blunt-leaved Sandwort, Arenaria lateriflora

Published status: Rare and Endangered in the Niagara Frontier Region (Zander and Pierce 1979).

Geographic factors:

(1) This species has a large North American distribution, which includes the western half of the continent and much of eastern Canada.

(2) The preferred site is near the southern limit of the species' North American range.

(3) There are six known stations of Blunt-leaved Sandwort in the Regional Municipality of Niagara.

Demographic factors:

(1) Site population characteristics are unknown.

Evaluation comments:

This is the only one of the eight species which is defined as regionally rare and endangered. "Endangered" is defined by Zander and Pierce (1979) as "easily extirpated". Blunt-leaved Sandwort is considered common in both adjacent New York State (Mitchell, pers. comm.; 1986) and adjacent Norfolk County (Landon 1960) but regionally uncommon in the Regional Municipality of Haldimand-Norfolk. It is a small ephemeral species which is likely easily overlooked and few data are available regarding its local distribution and abundance.

- Intermediate Leather Grape Fern, Botrychium multifidum

Published status: Rare in the Niagara Frontier Region (Zander and Pierce 1979).

Geographic factors:

(1) The species occupies a large range covering most of central North America.

(2) The station in the site vicinity study area occurs near the southern limit of its continental range.

(3) No other stations of Intermediate Leather Grape Fern are known in the Regional Municipality of Niagara.

Demographic factors:

(1) Several stems were located in one area of the site vicinity.

Evaluation comments:

This fern has a large North American range and is considered common in adjacent New York State (Mitchell, pers. comm., 1986). It is considered very uncommon in the Regional Municipality of Haldimand-Norfolk, where it is apparently restricted to the Norfolk Sand Plain (Sutherland 1987).

F-2.2.3 LOW SIGNIFICANCE SPECIES

- Canada Plum, *Prunus nigra*

Published status: Rare in the Niagara Frontier Region (Zander and Pierce 1979)

Geographic factors:

(1) The North American distribution of Canada Plum occurs in a wide band across most of central and eastern North America into southern Canada.

(2) The station in the site vicinity study area is situated in the northern half of its continental range.

(3) There are approximately 10 known stations of Canada Plum in the Regional Municipality of Niagara.

Demographic factors:

(1) One individual was observed in the site vicinity study area, but provided no evidence of fruiting.

Evaluation comments:

This species is considered common throughout southern Ontario (Soper and Heimberger 1982) and common in adjacent New York State (Mitchell, pers. comm., 1986). It is considered uncommon in the Regional Municipality of Haldimand-Norfolk but probably common on the Haldimand Clay Plain portion of that region (Sutherland 1987).

APPENDIX G:

LIST OF BIRD SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

APPENDIX G : LIST OF BIRD SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

COMMON NAME	SCIENTIFIC NAME	SITE		SITE VICINITY	
		PHASE		PHASE	
		4A	4B	4A	4B
Common Loon	Gavia immer	X			
Great Blue Heron	Ardea herodias	X	X	X	X
Green-backed Heron	Butorides striatus			X	X
Black-crowned Night-Heron	Nycticorax nycticorax				X
Canada Goose	Branta canadensis			X	X
Wood Duck	Aix sponsa				X
Mallard	Anas platyrhynchos		X	X	X
Northern Pintail	Anas acuta				X
Blue-winged Teal	Anas discors		X	X	
Lesser Scaup	Aythya affinis				X
Turkey Vulture	Cathartes aura	X	X	X	X
Northern Harrier	Circus cyaneus	X			
Sharp-shinned Hawk	Accipiter striatus		X		X
Cooper's Hawk	Accipiter cooperii				X
Red-tailed Hawk	Buteo jamaicensis	X	X	X	X
Rough-legged Hawk	Buteo lagopus				X
American Kestrel	Falco sparverius	X	X	X	X
Ring-necked Pheasant	Phasianus colchicus			X	
Ruffed Grouse	Bonasa umbellus	X		X	X
Virginia Rail	Rallus limicola			X	
Sora	Porzana carolina			X	
Killdeer	Charadrius vociferus	X	X	X	X
Lesser Yellowlegs	Tringa flavipes		X		X
Spotted Sandpiper	Actitis macularia			X	X
Upland Sandpiper	Bartramia longicauda		X	X	
Common Snipe	Gallinago gallinago		X	X	
American Woodcock	Scolopax minor	X	X	X	X
Ring-billed Gull	Larus delawarensis	X	X		X
Herring Gull	Larus argentatus		X		X
Rock Dove	Columba livia	X	X	X	X
Mourning Dove	Zenaida macroura	X	X	X	X
Black-billed Cuckoo	Coccyzus erythropthalmus		X	X	
Eastern Screech-Owl	Otus asio			X	X
Great Horned Owl	Bubo virginianus		X	X	X
Chimney Swift	Chaetura pelagica	X			
Ruby-throated Hummingbird	Archilochus colubris			X	X
Belted Kingfisher	Ceryle alcyon	X			
Red-headed Woodpecker	Melanerpes erythrocephalus	X		X	X
Yellow-bellied Sapsucker	Sphyrapicus varius		X		X
Downy Woodpecker	Picoides pubescens	X	X	X	X
Hairy Woodpecker	Picoides villosus	X	X		X
Northern Flicker	Colaptes auratus	X	X	X	X
Pileated Woodpecker	Dryocopus pileatus				X
Eastern Wood-Pewee	Contopus virens		X	X	X
Alder Flycatcher	Empidonax alnorum		X	X	
Willow Flycatcher	Empidonax traillii		X	X	X

APPENDIX G : LIST OF BIRD SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

COMMON NAME	SCIENTIFIC NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
Least Flycatcher	*Empidonax minimus*		X	X	X
Great Crested Flycatcher	*Myiarchus crinitus*		X	X	X
Eastern Kingbird	*Tyrannus tyrannus*		X	X	X
Horned Lark	*Eremophila alpestris*		X	X	X
Purple Martin	*Progne subis*	X		X	X
Tree Swallow	*Tachycineta bicolor*		X	X	X
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*			X	
Barn Swallow	*Hirundo rustica*	X	X	X	X
Blue Jay	*Cyanocitta cristata*	X	X	X	X
American Crow	*Corvus brachyrhynchos*	X	X	X	X
Black-capped Chickadee	*Parus atricapillus*	X	X	X	X
White-breasted Nuthatch	*Sitta carolinensis*	X	X	X	X
Brown Creeper	*Certhia americana*		X	X	
House Wren	*Troglodytes aedon*	X		X	
Golden-crowned Kinglet	*Regulus satrapa*		X		
Ruby-crowned Kinglet	*Regulus calendula*		X		
Blue-gray Gnatcatcher	*Polioptila caerulea*		X	X	X
Eastern Bluebird	*Sialia sialis*	X			
Veery	*Catharus fuscescens*		X	X	X
Swainson's Thrush	*Catharus guttatus*		X		X
Wood Thrush	*Hylocichla mustelina*		X	X	X
American Robin	*Turdus migratorius*	X	X	X	X
Gray Catbird	*Dumetella carolinensis*	X	X	X	X
Northern Mockingbird	*Mimus polyglottos*	X		X	X
Brown Thrasher	*Toxostoma rufum*	X	X	X	X
Cedar Waxwing	*Bombycilla cedrorum*	X	X	X	X
European Starling	*Sturnus vulgaris*	X	X	X	X
Yellow-throated Vireo	*Vireo flavifrons*				X
Warbling Vireo	*Vireo gilvus*	X	X	X	X
Red-eyed Vireo	*Vireo olivaceus*		X	X	X
Tennessee Warbler	*Vermivora peregrina*				X
Nashville Warbler	*Vermivora ruficapilla*				X
Yellow Warbler	*Dendroica petechia*	X	X	X	X
Chestnut-sided Warbler	*Dendroica pensylvanica*				X
Cape May Warbler	*Dendroica tigrina*				X
Yellow-rumped Warbler	*Dendroica coronata*		X		X
Black-throated Green Warbler	*Dendroica virens*			X	X
Blackburnian Warbler	*Dendroica fusca*				X
Bay-breasted Warbler	*Dendroica castanea*				X
Cerulean Warbler	*Dendroica cerulea*		X		
American Redstart	*Setophaga ruticilla*		X		
Ovenbird	*Seiurus aurocapillus*		X	X	X
Common Yellowthroat	*Geothlypis trichas*	X	X	X	X
Canada Warbler	*Wilsonia canadensis*				X
Scarlet Tanager	*Piranga olivacea*				X
Northern Cardinal	*Cardinalis cardinalis*		X	X	X

APPENDIX G : LIST OF BIRD SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

COMMON NAME	SCIENTIFIC NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
Rose-breasted Grosbeak	Pheucticus ludovicianus		X	X	X
Indigo Bunting	Passerina cyanea	X	X		X
Rufous-sided Towhee	Pipilo erythrophthalmus			X	X
American Tree Sparrow	Spizella arborea	X	X		X
Chipping Sparrow	Spizella passerina		X		X
Field Sparrow	Spizella pusilla		X	X	X
Vesper Sparrow	Pooecetes gramineus		X	X	X
Savannah Sparrow	Passerculus sandwichensis	X	X	X	X
Song Sparrow	Melospiza melodia	X	X	X	X
Swamp Sparrow	Melospiza georgiana	X		X	
White-throated Sparrow	Zonotrichia albicollis		X		X
White-crowned Sparrow	Zonotrichia leucophrys		X		
Dark-eyed Junco	Junco hyemalis		X		X
Snow Bunting	Plectrophenax nivalis				X
Bobolink	Dolichonyx oryzivorus		X	X	X
Red-winged Blackbird	Agelaius phoeniceus	X	X	X	X
Eastern Meadowlark	Sturnella magna	X	X	X	X
Rusty Blackbird	Euphagus carolinus				X
Common Grackle	Quiscalus quiscula	X	X	X	X
Brown-headed Cowbird	Molothrus ater	X	X	X	X
Orchard Oriole	Icterus spurius	X		X	
Northern Oriole	Icterus galbula	X	X	X	X
House Finch	Carpodacus mexicanus	X			
Common Redpoll	Carduelis flammea				X
American Goldfinch	Carduelis tristis	X	X	X	X
House Sparrow	Passer domesticus	X	X	X	X

APPENDIX H

LIST OF MAMMAL SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

APPENDIX H : LIST OF MAMMAL SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

COMMON NAME	SCIENTIFIC NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
Virginia Opossum	Didelphis virginiana	X	X	X	X
Common Shrew	Sorex cinereus		X		X
Short-tailed Shrew	Blarina brevicauda		X		X
Eastern Cottontail	Sylvilagus floridanus	X	X	X	X
European Hare	Lepus europaeus		X	X	
Eastern Chipmunk	Tamias striatus		X	X	X
Woodchuck	Marmota monax				X
Grey Squirrel	Sciurus carolinensis	X	X	X	X
American Red Squirrel	Tamiasciurus hudsonicus				X
Deer Mouse	Peromyscus maniculatus	X			
White-footed Mouse	Peromyscus leucopus		X		X
Muskrat	Ondatra zibethicus	X	X	X	X
Meadow Vole	Microtus pennsylvanicus	X	X		
Norway Rat	Rattus norvegicus			X	
Meadow Jumping Mouse	Zapus hudsonicus	X			X
Coyote	Canis latrans	X			X
Red Fox	Vulpes vulpes	X	X	X	X
Raccoon	Procyon lotor	X	X	X	X
American Mink	Mustela vison	X	X	X	
Striped Skunk	Mephitis mephitis	X			X
Lynx	Lynx lynx			X	
Bobcat	Lynx rufus	X			
White-tailed Deer	Odocoileus virginianus	X	X	X	X

APPENDIX I

LIST OF AMPHIBIANS AND REPTILES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

APPENDIX I : LIST OF AMPHIBIANS AND REPTILES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

COMMON NAME	SCIENTIFIC NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
Eastern Newt	Notophthalmus viridescens				X
Redback Salamander	Plethodon cinereus		X		X
American Toad	Bufo americanus	X	X		X
Spring Peeper	Hyla crucifer	X	X		X
Tetraploid Gray Treefrog	Hyla versicolor	X			X
Striped Chorus Frog	Pseudacris triseriata	X	X		X
Wood Frog	Rana sylvatica	X	X		X
Leopard Frog	Rana pipiens	X	X		X
Green Frog	Rana clamitans		X		X
Bullfrog	Rana catesbeiana			X	
Snapping Turtle	Chelydra serpentina			X	X
Painted Turtle	Chrysemys picta			X	X
Garter Snake	Thamnophis sirtalis	X	X		X
Water Snake	Nerodia sipedon				X
Redbelly Snake	Storeria occipitomaculata		X		
Black Rat Snake	Elaphe obsoleta	X		X	
Milk Snake	Lampropeltis triangulum			X	

APPENDIX J

LIST OF BUTTERFLY SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

APPENDIX J : LIST OF BUTTERFLY SPECIES RECORDED ON THE PREFERRED SITE AND IN THE SITE VICINITY

COMMON NAME	SCIENTIFIC NAME	SITE PHASE		SITE VICINITY PHASE	
		4A	4B	4A	4B
Least Skipper	Ancyloxypha numitor		X		
European Skipper	Thymelicus lineola		X		X
Black Swallowtail	Papilio polyxenes		X		X
Tiger Swallowtail	Pterourus glaucus				X
Mustard White	Artogeia napi		X		
European Cabbage Butterfly	Artogeia rapae		X		X
Common Sulphur	Colias philodice		X		X
Alfalfa Butterfly	Colias eurytheme		X		X
Bronze Copper	Hyllolycaena hyllus				X
Edward's Hairstreak	Satyrium edwardsii				X
Spring Azure	Celastrina ladon		X		X
Great Spangled Fritillary	Speyeria cybele		X		X
Pearl Crescent	Phyciodes tharos		X		X
Question Mark	Polygonia interrogationis		X		
Mourning Cloak	Nymphalis antiopa				X
Milbert's Tortoiseshell	Aglais milberti				X
American Painted Lady	Vanessa virginiensis				X
Red Admiral	Vanessa atalanta		X		X
White Admiral	Basilarchia a. arthemis				X
Red-spotted Purple	Basilarchia a. astyanax				X
Viceroy	Basilarchia archippus				X
Eyed Brown	Satyrodes eurydice		X		X
Appalachian Eyed Brown	Satyrodes appalachia				X
Inornate Ringlet	Coenonympha inornata		X		X
Wood Nymph	Cercyonis pegala		X		X
Monarch	Danaus plexippus		X		X

APPENDIX K

LIST OF FISH SPECIES RECORDED IN 9C CREEK, BEAVER CREEK AND THE WELLAND RIVER

APPENDIX K : LIST OF FISH SPECIES RECORDED IN 9C CREEK,BEAVER CREEK AND THE WELLAND RIVER

COMMON NAME	SCIENTIFIC NAME	9C CREEK	BEAVER CREEK	WELLAND RIVER
Bowfin	Amia calva		X	X
Gizzard Shad	Dorosoma cepedianum		X	X
Northern Pike	Esox lucius		X	X
Central Mudminnow	Umbra limi	X	X	
White Sucker	Catostomus commersoni		X	X
Shorthead Redhorse	Moxostoma macrolepidotum		X	X
Common Carp	Cyprinus carpio	X	X	X
Golden Shiner	Notemigonus crysoleucas		X	X
Brown Bullhead	Ictalurus nebulosus		X	X
Channel Catfish	Ictalurus punctatus		X	X
Brook Stickleback	Culaea inconstans	X	X	
White Perch	Morone americana		X	X
Rock Bass	Ambloplites rupestris			X
Pumpkinseed	Lepomis gibbosus		X	X
White Crappie	Pomoxis annularis		X	X
Yellow Perch	Perca flavescens		X	X
Freshwater Drum	Aplodinotus grunniens		X	X

APPENDIX L

RARITY AND SIGNIFICANCE OF WILDLIFE AND FISH SPECIES

APPENDIX L

RARITY AND SIGNIFICANCE OF WILDLIFE AND FISH SPECIES

This appendix briefly describes the information sources published and unpublished) which were consulted during Phases 4A and 4B to determine the status of rare wildlife and fish species and their significance. Status was examined on three levels: national, provincial and regional.

Bird Species

Definitions of rarity for bird species were derived from a variety of sources. Rare status on a national level is designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Muir 1984).

Frequency and relative abundance standards are assigned to Ontario birds by James et al. (1976). The classification system employed in this document is a simplified version of the system developed by Arbib (1957).

Additional documentation of rare breeding bird species in Ontario is provided by Eagles and McCauley (1982), who divide types of rarity into nine subclassifications.

Reference to the work of Baillie and Harrington (1936, 1937), Snyder (1957) and deVos (1964b) provided a comparison of recent and historical abundance and distribution patterns. Collectively, these sources document significant status changes which have occurred in this century.

Seven species of birds have been officially listed as "Endangered" in the Province of Ontario (OMNR 1977) and are accorded legal protection under the Endangered Species Act (Ontario Government 1971).

Regional rarity was determined largely on the basis of published information (if such is available), supplemented by unpublished observations and the testimony of knowledgeable individuals familiar with the birdlife of the Niagara Peninsula.

Two annotated lists of the regional avifauna were relied upon heavily when determining the status of birds in the Niagara Peninsula. The geographical scope of Beardslee and Mitchell's (1965) account encompasses a large portion of neighbouring New York State, while Sheppard's (1970) treatment is confined to the Ontario side. Previous published lists (Sheppard _et_ _al_. 1936; Sheppard 1939) contain references to the historical status of selected species.

In assigning status, Beardslee and Mitchell (1965) adopt the criteria and terms established by the Federation of New York State Bird Clubs in 1954. These differ somewhat from the criteria used by James _et_ _al_. (1976) to determine status on a provincial level. Terms used by Sheppard (1970) to describe abundance and frequency of occurrence are not defined.

More recent information on the status of breeding birds in the Niagara Region was largely gleaned from discussions with local experts. Data compiled by the Ontario Breeding Bird Atlas Project for the years 1981-1985 inclusive were also consulted.

Mammal species

As of April 1984, 20 species of mammals have been designated as "Endangered", "Threatened" or "Rare" in Canada by COSEWIC (Muir 1984).

Banfield (1974) deals with the status of Canadian mammals but does not provide definitions for the various terms used.

Provincial status is not addressed in Dagg's (1974) account of Ontario mammals. Although somewhat outdated, R.L. Peterson's The Mammals of Eastern Canada (1966) is still considered to be the authoritative treatise on the subject.

deVos (1964a) documents changes in the distribution and abundance of various Ontario mammals dating back to the last century. A series of recent status reports prepared for the Ontario Ministry of Natural Resources review the historical and present day status of rare species.

There are no known annotated lists of the mammalian fauna of the Regional Municipality of Niagara. Duncan (1985) recently reviewed the regional status of the Virginia Opossum. Information supplied by local naturalists and recognized authorites in the field of mammalogy was also relied upon to determine the regional status of particular species. Campbell and Dagg's (1972) account of the mammalian fauna of Waterloo and South Wellington Counties and Gartshore's (1987) list of the mammals of the Regional Municipality of Haldimand-Norfolk were also consulted, as this area is considered to be fairly representative of southern Ontario as a whole.

Reptiles and amphibians

Cook (1976) reviewed the status of the Canadian herpetofauna and identified 23 "Endangered" and "Threatened" species. To date, however, only one species has been officially recognized as "Endangered" by COSEWIC (Muir 1984).

Provincially rare reptiles and amphibians have been identified in a series of Ontario Ministry of Natural Resources status reports. Three of these species are considered "Endangered" in Ontario (OMNR 1977).

Regional rarity is more difficult to assess due to a paucity of published information concerning the herpetofauna of specific southern Ontario localities. Logier and Toner (1961) and Oldham and Sutherland (1986) list reptile and amphibian specimen localities from the Niagara Region, but neither assign regional status. A survey of the amphibians and reptiles of the Niagara Escarpment Planning Area (Campbell 1976) also includes reference to Niagara. Campbell (1977) provides a review of the provincial and regional status of the Black Rat Snake, with particular emphasis on Haldimand-Norfolk Region.

Fish

Status reviews of "Endangered", "Threatened" and "Rare" fish in Canada and southern Ontario have recently been published by McAllister *et al*. (1985) and Beak Consultants Limited (1980), respectively. There is presently no information available regarding the regional status of fish in Niagara.

Butterflies

One butterfly species is presently protected in Ontario by endangered species legislation (Government of Ontario 1971; OMNR 1977). The population status of rare Ontario butterflies are periodically reviewed in various entomological and natural history journals, but information concerning regionally rare species is lacking.

APPENDIX M

GLOSSARY

APPENDIX M

GLOSSARY

AIBR:	Area of Important Biological Resources. Examples of AIBRs include significant wildlife and waterfowl habitat (e.g., deer wintering areas, waterfowl staging areas, and large continuous areas which provide wildlife travel corridors) and significant fisheries habitat (e.g., areas which support a recreational fishery, bait fishery or spawning/migratory area) (Lindsay 1981).
ANSI:	Area of Natural and Scientific Interest. These are areas of land and water which contain natural landscapes or features which have been identified as having values related to protection, natural heritage appreciation, scientific study or education (OMNR 1987a)
Association:	A term used to describe an area of uniform vegetation cover characterized by diagnostic or representative plant species (Mueller-Dombois and Ellenberg 1974).
Basal area at breast height:	the area of a cross-section through a tree stem from the outer bark surface, measured at breast height on the tree (approx. 1.5 m above the ground).

Carolinian Zone:	that part of Ontario south of a line extending from Grand Bend to Toronto which contains native plant and animal taxa typical of the Deciduous Forest Region, many of which are at the northern limit of their ranges.
Constancy:	the percentage of sampled stands in which a particular plant species occurs.
Coppice:	an individual specimen of a tree with more than one stem originating from the roots. Basswood (*Tilia americana*) frequently displays this growth habit.
Cover:	the vertical projection of the crown or shoot area of a plant species to the ground surface expressed as a fraction or percent of a reference area (Mueller-Dombois and Ellenberg 1974).
CUE:	catch per unit effort. Term used in fish sampling to indicate the number of fish captured in a specific unit of time (e.g., 24 hours).
Diameter at breast height:	common forestry measurement similar to basal area at breast height but only a measure of the diameter (cm) of a cross-section through the tree stem. Measured from the outer bark surface approximately 1.5 m above ground level.
Dominant:	species which affect control over a large portion of a vegetation association or wildlife community through greater size, number or other characters.

Dry-mesic:	see soil moisture.
Edge:	the interface between two adjoining habitat types (i.e. forest/field).
ESA:	Environmentally Significant /Sensitive Area. These are "natural landscapes, including those lands and waters of inherent biological sensitivity, such as those areas containing aquifer recharges, headwaters, unusual plants, wildlife or landforms, breeding or overwintering habitats, vital ecological functions, rare or endangered species or other combinations of habitat and landform, which could be valuable for scientific research or conservation education" (Eagles and Adindu 1975).
Flora:	the total list of plants found growing in an area (Maycock 1981).
Herb Layer:	herbaceous vegetation from <30 cm to 1 m in height (Mueller-Dombois and Ellenberg 1974).
Herpetofauna:	reptiles and amphibians
Hibernaculum:	a den site where snakes congregate during winter
Homogeneous:	uniform plant cover, without large openings and with consistently represented plant species or life forms, from one location or another.

Importance value:	a quantitative value which sums relative values calculated for the density, frequency and dominance of a particular tree species. For a particular stand, the sum of all tree importance values should equal approximately 300. The higher the value for an individual tree species, the more important that species is in a particular stand.
Insectivores:	insect-eating mammals (e.g., shrews, moles).
Mesic:	see soil moisture.
Microtives:	collectively refers to mice and moles.
Moss and lichen layer:	ground vegetation less than 10 cm high composed of mosses and lichens.
Quadrant:	one-quarter of a circle's circumference.
Quadrat:	a square area of delineated size.
Representative:	a species which commonly occurs in a particular vegetation association. Characteristic of environmental conditions present in that association, it is some times referred to as diagnostic.
Scat:	animal feces.

Significant Environmental Unit:	a term which collectively refers to an Environmentally Sensitive/Significant Area, an Area of Natural and Scientific Interest, or an Area of Important and Biological Resources.
Shrub Layer:	woody vegetation cover between 30 cm and 5 m in height (Mueller-Dombois and Ellenberg 1974).
Soil moisture:	basis for the characterization of site types. A relative scale ranging for this study from dry-mesic to mesic to wet-mesic, with mesic being the mid-point on the scale. Each class of soil moisture is dominated by different tree species and associated understory and groundflora.
Species Richness:	the total number of species found in a given area.
Spring ephemeral:	a plant species which flowers very early in the growing season and for a short duration.
Stand:	an area usually with some minimum area requirement, which is characterized by uniform habitat and homogeneous plant cover (Mueller-Dombois and Ellenberg 1974). In this study, a minimum stand area of 0.5 ha was selected.

Station:	one or more individuals of a plant species growing in close proximity to one another. Usually a station represents a very specific location for the occurrence of a particular species, but can also refer to a broad habitat type or vegetation community which supports a more widespread population of that species. The term station is often used in reference to specific locational data on herbarium specimen records.
Stem mid-point:	an imaginary point at the centre of the tree stem, equidistant between bark surfaces.
Trap night:	a term used in small mammal trapping to indicate a single night during which a a trap was set. Captures of small mammals are usually expressed as a catch/100 TN (trap nights) to provide a common basis for comparison.
Tree layer:	• any woody plant taller than 5 metres (Mueller-Dombois and Ellenberg 1974). • tree - any woody plant with a minimum stem dbh (diameter at breast height) of 4 inches (10 cm) (Curtis 1959). • sapling - any woody plant with a stem dbh between 1 and 4 inches (2.5 cm-10 cm), capable of becoming a tree (Curtis 1959).

Tree layer: (cont'd)	• seedling - any woody plant with a stem dbh of <1 inch (<2.5 cm), capable of becoming a tree (Curtis 1959).
Vegetation:	a numerical and quantitative analysis of an area's plant cover (Maycock 1981).
Wet mesic:	see soil moisture.
Woodlot:	block of forested land surrounded by non-forest land. It can include several stands or vegetation associations.

APPENDIX N

DEFINITIONS OF VEGETATION COVER TYPES

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DEFINITIONS OF VEGETATION COVER TYPES

The following definitions are drawn from several published works, in particular a study completed by Ontario Hydro (Ecologistics Limited 1982). Modifications have been made to suit the geographic areas examined. Sources relied upon are listed in Section 11.0.

FOREST: Forest is defined as land having greater than 50% canopy cover composed of tree species greater than 6 m tall (Curtis 1959).

DECIDUOUS:	forest is composed of 80% or more deciduous trees.
CONIFEROUS:	forest is composed of 80% or more coniferous trees.
MIXED FOREST:	is a combination of deciduous and coniferous species, not matching the former definitions.

THICKETS: Thicket lands must have a canopy cover of greater than 25%, composed of shrub species (OMNR 1983) with less than 10% composed of tree species >6 m tall.

FIELD: Field associations occur in varying degrees of succession. This system classifies fields according to the degree of natural vegetation present, ranging from a cultivated crop devoid of native plants to an old field with a larger percentage of native herbaceous plants.

CROPLAND: This is land currently in agricultural production for crops or pasture. These activities inhibit the succession of native vegetation. Also included in this designation are fallow lands planted in crops in the past and awaiting agricultural production in the future.

RECENTLY DISTURBED FIELDS: This vegetation cover type involves fields which have experienced recent disturbances, resulting in their subsequent domination mainly by non-native plant taxa.

Such disturbances could include past agricultural practices (e.g., crop production) or the clearcutting of forested lands.

Assuming further disturbances do not occur, the vegetation will progress to that associated with old fields.

OLD FIELDS: At least two of the five dominant plants growing in old fields must be native species, not typical of disturbed sites (Pratt 1979). While dominated by herbs and grasses, a pioneer thicket community of up to 25% canopy and a tree community of up to 10% canopy may be present.

This is a very general definition. The distinction between recently disturbed and old fields is at times difficult to make. The rate of field succession is dependent upon a number of factors including moisture regime and soil conditions.

The perception of the ratio of native versus non-native species in a field is also dependent upon the season observed. For example. goldenrods may appear dominant in the late summer, flowering when other groups of plants are past flowering and therefore less visible (Maycock and Guzikowa 1984).

MARSH: The marshes encountered in this study are generally small and associated with wet, lowland depressions. These communities are dominated by narrow-leaved, broad-leaved and robust emergent plant species including Narrow-leaved Cattail and Rice Cut

Grass. Patches of marsh dominated by open water, with floating and submerged plants, are also present.

UNCLASSIFIED: Residential and manicured areas and open bodies of water are included in this designation. Disturbance to vegetation, such as the introduction of non-native species and the mowing of grassed areas, are common features of this cover type.

MAPS
NOT
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CARTES
OMISES